BayRS Version 14.20

Part No. 308635-14.20 Rev 00
September 2000

600 Technology Park Drive
Billerica, MA 01821-4130

Configuring LLC Services

NORTEL NETWORKS™

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Preface

This guide describes Logical Link Control (LLC) services and what you do to start and customize LLC services on a Nortel Networks™ router. By customizing your router for LLC services, you open your network to LAN Network Manager (LNM) servers, data link switching (DLSw) services, and Advanced Peer-to-Peer Networking (APPN).

You can use the Bay Command Console (BCC™) or Site Manager to configure LLC on a router. In this guide, you will find instructions for using both the BCC and Site Manager.

Before You Begin

Before using this guide, you must complete the following procedures. For a new router:

- Install the router (see the installation guide that came with your router).
- Connect the router to the network and create a pilot configuration file (see *Quick-Starting Routers*, *Configuring BayStack Remote Access*, or *Connecting ASN Routers to a Network)*.

Make sure that you are running the latest version of Nortel Networks BayRS™ and Site Manager software. For information about upgrading BayRS and Site Manager, see the upgrading guide for your version of BayRS.

Text Conventions

This guide uses the following text conventions:

angle brackets (< >)	Indicate that you choose the text to enter based on the description inside the brackets. Do not type the brackets when entering the command. Example: If the command syntax is: **ping** <*ip_address*>, you enter: **ping 192.32.10.12**
bold text	Indicates command names and options and text that you need to enter. Example: Enter **show ip** {**alerts** | **routes**}. Example: Use the **dinfo** command.
braces ({ })	Indicate required elements in syntax descriptions where there is more than one option. You must choose only one of the options. Do not type the braces when entering the command. Example: If the command syntax is: **show ip** {**alerts** | **routes**}, you must enter either: **show ip alerts** or **show ip routes**, but not both.
brackets ([ ])	Indicate optional elements in syntax descriptions. Do not type the brackets when entering the command. Example: If the command syntax is: **show ip interfaces** [**-alerts**], you can enter either: **show ip interfaces** or **show ip interfaces -alerts**.
ellipsis points (. . .)	Indicate that you repeat the last element of the command as needed. Example: If the command syntax is: **ethernet/2/1** [<*parameter*> <*value*>] **. . .** , you enter **ethernet/2/1** and as many parameter-value pairs as needed.

italic text	Indicates file and directory names, new terms, book titles, and variables in command syntax descriptions. Where a variable is two or more words, the words are connected by an underscore. Example: If the command syntax is: **show at** <*valid_route*> *valid_route* is one variable and you substitute one value for it.
`screen text`	Indicates system output, for example, prompts and system messages. Example: `Set Trap Monitor Filters`
separator (>)	Shows menu paths. Example: Protocols > IP identifies the IP option on the Protocols menu.
vertical line (|)	Separates choices for command keywords and arguments. Enter only one of the choices. Do not type the vertical line when entering the command. Example: If the command syntax is: **show ip** {**alerts** | **routes**}, you enter either: **show ip alerts** or **show ip routes**, but not both.

Acronyms

This guide uses the following acronyms:

ANSI	American National Standards Institute
APPN	Advanced Peer-to-Peer Networking
ATM	asynchronous transfer mode
BAN	Boundary Access Node
BNI	Boundary Node Identifier
BNN	Boundary Network Node
DLCI	data link connection identifier
DLSw	data link switching
DNA	data network address
DSPU	downstream physical unit
DSAP	destination service access point
FDDI	Fiber Distributed Data Interface
FEP	front-end processor
FR	frame relay
FRAD	Frame Relay Access Device
FRMR	frame reject
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ISO	International Standards Organization
ITU-T	International Telecommunication Union-Telecommunications sector [formerly CCITT]
LAN	local area network
LANE	LAN emulation
LEC	LAN emulation client
LLC	logical link control
LNM	LAN Network Manager

LSAP	link service access point
LSB	least significant bit
LSDU	link service data unit
MAC	media access control
MSB	most significant bit
NCP	Network Communications Program
NetBIOS	Network Basic Input-Output System
OSI	Open Systems Interconnection
PDU	protocol data unit
PPP	Point-to-Point Protocol
PVC	permanent virtual circuit
RFC	Request for Comment
RNR	receiver not ready
SABME	set asynchronous balanced mode extended
SAP	service access point
SDLC	Synchronous Data Link Control
SNA	Systems Network Architecture
SR	source routing
SRB	source route bridging
SSAP	source service access point
SVC	switched virtual circuit
WAN	wide area network

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Chapter 1
Logical Link Control Overview

LLC is a standard protocol within the ITU-T (formerly CCITT) 8802.2 and IEEE 802.*x* family of LAN standards. Connection-oriented protocols, including IBM Systems Network Architecture (SNA) and NetBIOS, use LLC services. Connection-oriented protocols do not have a network layer address (such as an IP subnet) to route information. Instead, before any information transfer occurs, a device on the network sends a "broadcast" or "explorer" frame to locate the session partner. From this broadcast, the network establishes a path for the data transfer.

LLC2 traffic is generally sensitive to excessive network delays, causing problems with SNA and NetBIOS sessions. Data link switching (DLSw) and Advanced Peer-to-Peer Networking (APPN) resolve these problems by locally terminating the LLC2 session at the router, and providing a local acknowledgment to SNA/NetBIOS workstations. The LLC2 subsystem provides these services.

The Nortel Networks implementation of the LLC protocol consists of LLC Class 1 (LLC1), a connectionless service, and LLC class 2 (LLC2), a connection-oriented service. The subsystems that require LLC2 services are as follows:

- DLSw
- APPN
- LAN Network Manager (LNM)

Most other protocols use LLC1, or connectionless, delivery services.

Generally there is no need to change the LLC2 default settings. You can, however, tune the network by changing these default settings. In Site Manager, you should not select LLC2 on an interface without also selecting one of the preceding protocols.

Using LLC2 with SNA and NetBIOS

SNA needs a connection-oriented data link layer for end-to-end packet sequencing and error control. Over wide area networks (WANs), the Synchronous Data Link Control (SDLC) protocol has traditionally met this need. However, in a LAN environment, front-end processors (FEPs), controllers, and NetBIOS client/server stations commonly use an LLC2 layer for this purpose. To support communication among these devices, you can add LLC2 interfaces to a router configuration.

SNA devices and NetBIOS PCs use LLC when they establish sessions through a LAN topology. SNA and NetBIOS need LLC2 connection-oriented circuits to provide higher-layer sequencing and error control in bridged LAN environments. LLC2 works much like SDLC for packet sequencing and acknowledgment. Unlike SDLC, it does not impose unbalanced, primary/secondary relationships between communicating nodes. Any LLC station can initiate a peer-to-peer conversation with any other LLC station.

Supported Connections

You configure LLC2 on any interface requiring local termination, including:

- APPN interfaces
- DLSw interfaces

  When you connect over an IP backbone in dual-switch DLSw configurations, the interface attached to the IP backbone does not use LLC2. When you connect over an LLC2 backbone in DLSw single-switch configurations, the interface attached to the backbone uses LLC2.
- Token ring interfaces running LNM

You can enable LLC2 on any LAN or WAN interface that supports APPN, DLSw, and LNM, including:

- LAN interfaces
  - -- Token ring
  - -- Ethernet
  - -- Any other LAN media supporting source route bridging (SRB), including FDDI

- WAN interfaces
  - -- Frame relay Boundary Network Node (BNN) and Boundary Access Node (BAN) interfaces
  - -- Any other WAN media supporting source route bridging traffic, including Point-to-Point Protocol (PPP)

Frame Relay Support

Figure 1-1 illustrates the connection of a host through a frame relay network, in a configuration with multiprotocol traffic to other locations.

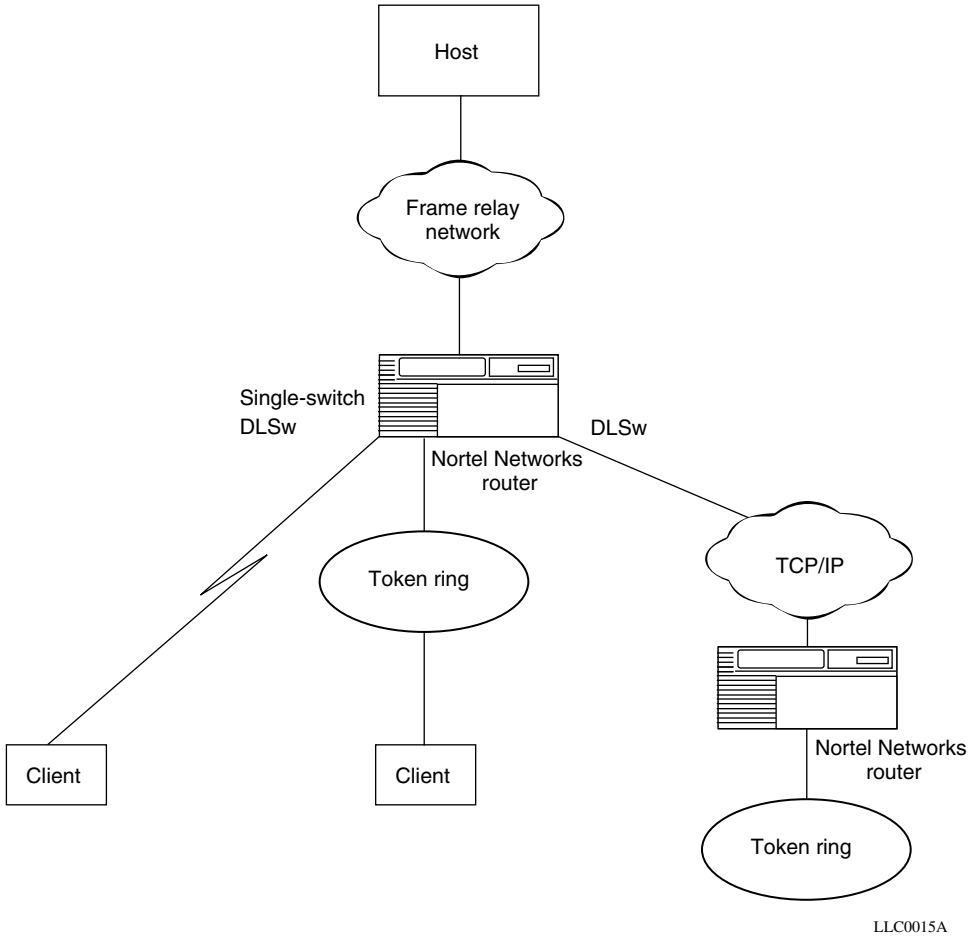

Figure 1-1. Sample Frame Relay Network

Nortel Networks provides two ways to communicate directly with an SNA processor (such as an IBM 3745 or AS/400) over frame relay:

- Boundary Network Node
- Boundary Access Node

Boundary Network Node

The Boundary Network Node refers to the RFC 1490 specification for routed SNA over frame relay. This implementation of LLC2 also complies with the Frame Relay Forum 3 (FRF.3), “Multiple Protocol Encapsulation over Frame Relay Implementation Agreements,” which defines how SNA traffic traverses a frame relay network.

BNN allows native SNA traffic (originating from SDLC LAN- or WAN-attached devices) to communicate over public or private frame relay networks directly with an SNA processor. Devices can communicate with intermediate routing nodes or in a single-switch configuration function as a Frame Relay Access Device (FRAD).

PVC Support

Since BNN does not carry the destination and source MAC addresses in the network packets, the BNN format carries the fewest number of bits per packet and yields low network overhead. Therefore, you must explicitly define a permanent virtual circuit (PVC) to carry a packet to its destination. You do this with the LLC2 frame relay mapping table. The mapping table consists of three fields:

- DLCI, which represents a frame relay PVC
- Remote MAC, which is the destination MAC address
- Local MAC, which is the source MAC address

Each entry requires that you specify the Remote MAC, Local MAC, or both. A packet that matches this entry is then forwarded to the specified data link connection identifier (DLCI).

SVC Support

Using a switched virtual circuit (SVC) is very similiar to the BNN PVC over frame relay implementation. However, rather than requiring PVCs to always be available, you use an SVC to connect only when there is data to transfer.

The following features are supported with the SVC implementation:

- Providing a connection only after a client requests a session (for example, through sending a test poll.)
- Disconnecting when an SVC is not in use.
- Mapping remote and local MAC addresses to E.164 or X.121 addresses.
- Directing multiple client connection requests to a single destination MAC address over a single SVC by modifying the source (local) service access point (SAP.) SAPs are created at the receiving side and source MAC addresses are automatically created.

Boundary Access Node

The Boundary Access Node (BAN) is an IBM router enhancement. BAN refers to the RFC 1490 specification for bridged SNA over frame relay. The associated IBM NCP 7.3 enhancement is called the Boundary Node Identifier (BNI).

Since BAN carries the destination and source MAC addresses in the network packets, this format carries more bits per packet.

Standard BAN uses the source route bridging frame format with local termination. Nortel Networks routers select BAN when you configure the frame relay network *with* source route encapsulation.

LLC 8802/802.2 Standards

The LLC protocols comply with the ITU-T (formerly CCITT) 8802.2 standard, and operate within the IEEE Project 802.*x* protocol stack. Figure 1-2 compares LLC's location in the 802.*x* protocol stack to its equivalent position in the ISO/OSI model.

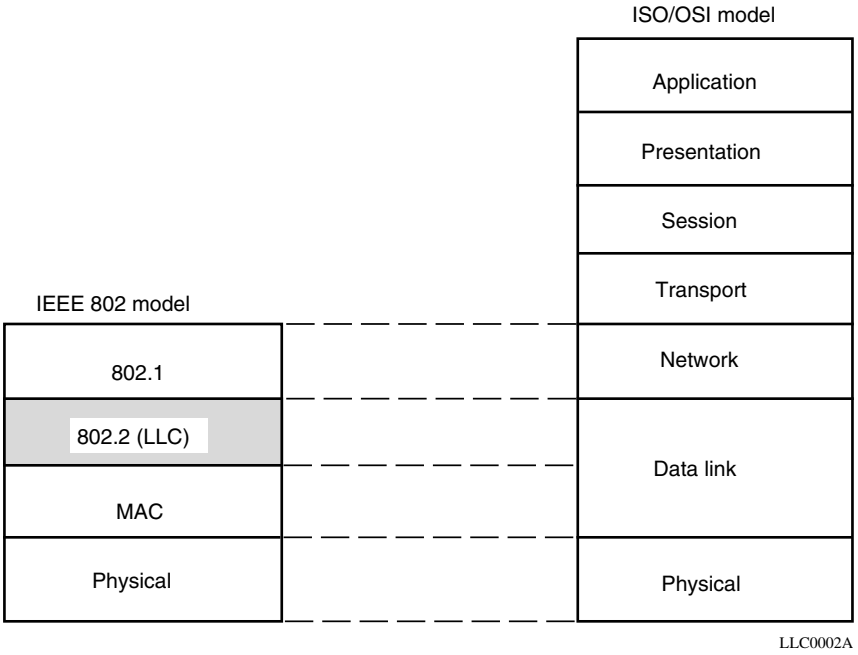

Figure 1-2. The LLC Sublayer in the IEEE 802.*x* and OSI Models

You can add an IEEE 802.2-compliant LLC interface to any physical circuit attached directly to an 8802.*x*/802.*x* LAN segment. Each interface services higher-level clients (networking protocols and applications) and is serviced by lower-level protocols (MAC and physical layers) operating within the router.

LLC Service Classes

The 802.2/LLC recommendations support three *service classes:*

- Connectionless unacknowledged (class 1 or LLC1)
- Connection-oriented (class 2 or LLC2)
- Connectionless acknowledged (class 3 or LLC3)

Note: The Nortel Networks implementation of LLC does not support the LLC3 service class.

LLC1 (Connectionless Service)

LLC1 is a datagram service that sends and receives LLC frames called link service data units (LSDUs) without requiring acknowledgment from the peer to assure delivery.

LLC1 supports all forms of communication (point-to-point, multipoint/multicast, and broadcast).

This service is appropriate for protocols that provide addressing, routing, recovery, and sequencing services at a higher layer.

LLC2 (Connection-Oriented Service)

LLC2 secures point-to-point virtual circuit connections between link service access points (LSAPs) by acting as follows:

- Responds to a higher-level protocol's request to open a connection through the data link layer
- Notifies a higher-level protocol that a connection through the data link layer has been established successfully
- Enables a higher-level protocol to govern LSDU activity by:
  - -- Sending or receiving LSDUs over an established data link layer connection
  - -- Sequencing LSDUs sent over a data link layer connection
  - -- Controlling the flow of LSDUs over a data link layer connection

The LLC2 also performs the following services:

- Responds to a request from a higher-level protocol to reset a connection to its initially connected state
- Responds to a request from a higher-level protocol to close an established connection

- Notifies a higher-level protocol that a connection previously established has been closed successfully

Because the connection occurs in the data link layer rather than in higher layers, LLC2 performs frame sequencing, flow control, and error recovery services for the data link layer.

LLC Operation Types

LLC supports two *operation types:*

- Unnumbered, unacknowledged (type 1)
- Numbered, acknowledged (type 2)

LLC1 supports only type 1 operations; LLC2 supports both type 1 and type 2 operations.

Type 1 Operations

Type 1 operations have the following characteristics:

- LLCs exchange protocol data units (PDUs) without establishing a data link connection.
- The peer does not acknowledge the PDUs it receives.
- There are no mechanisms for PDU sequencing, flow control, or error recovery, because higher-level protocols perform these services.

Type 2 Operations

Type 2 operations have the following characteristics:

- The LLC and its peer must establish a data link layer, virtual circuit/connection prior to any exchange of data.
- The source and destination are peer LLCs in an asynchronous, balanced data link connection.
- The source and destination LLCs control traffic by means of a numbering scheme for the sequential transfer of PDUs. The PDUs for each virtual circuit/connection have independent sequence-numbering schemes.
- The destination LLC acknowledges data PDUs that the source LLC sends by informing the source LLC of the next sequence number expected.

LLC Functionality

The LLC sublayer, which can support multiple logical links concurrently:

- Initiates and terminates control signal interchange with the XID, TEST, SABME, and DISC PDUs.
- Organizes data flow with the U, I, and UA PDUs. The level of organization differs between type 1 and type 2 operations.
- Interprets command PDUs it receives, and generates appropriate response PDUs, which differ between type 1 and type 2 operations and LLC1 and LLC2 service.
- Manages error control and recovery with the REJ, RR, RNR, and FRMR PDUs.

The LLC protocols generate and interpret command packets or frames called protocol data units (PDUs), which Table 1-1 describes. Table 1-1 lists type 1 and type 2 *command PDUs* and their counterpart *response PDUs*.

Table 1-1. LLC Command PDUs

Operation Type	Command	Response
Type 1	Unnumbered information (UI)	No response
	Exchange identification (XID)	Exchange identification (XID)
	Test (TEST)	Test (TEST)
Type 2	Information (I)	Information (I)
	Receiver ready (RR)	Receiver ready (RR)
	Receiver not ready (RNR)	Receiver not ready (RNR)
	Reject (REJ)	Reject (REJ)
	Set asynchronous balanced mode extended (SABME)	Unnumbered acknowledgment (UA)
	Disconnect (DISC)	Disconnected mode (DM)
	No command	Frame reject (FRMR)

Type 1 operations do not include definition of an acknowledgment PDU.

Type 2 operations do not include a command PDU counterpart for the FRMR response PDU.

LLC Protocol Data Unit Formats

The LLC PDU contains fields for addressing, control, and data, as shown in Figure 1-3. This section describes each field of the LLC PDU.

DSAP	SSAP	Control	Information field
8 bits	8 bits	8 or 16 bits	Variable; 8 bits each packet

Figure 1-3. LLC PDU Structure

Destination SAP (DSAP)

The DSAP address field identifies one or more service access points (SAPs) for which the LLC PDU is intended. The DSAP field contains 7 bits of actual address and 1 address designation bit to indicate an individual (I) destination address or a group (G) destination address, as shown in Figure 1-4.

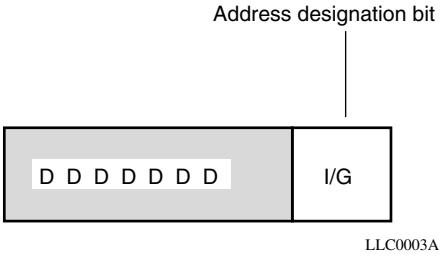

Figure 1-4. DSAP Address Field

A value of 0 for the address designation bit indicates that the PDU is destined for an individual SAP.

A value of 1 for the address designation bit indicates that the PDU is destined for a group-level SAP.

Source SAP (SSAP)

The SSAP address field identifies the specific service access point that initiated the PDU. The SSAP field contains 7 bits of actual address and 1 command/response identifier bit to indicate that the LLC PDU is a command (C) PDU or a response (R) PDU, as shown in Figure 1-5.

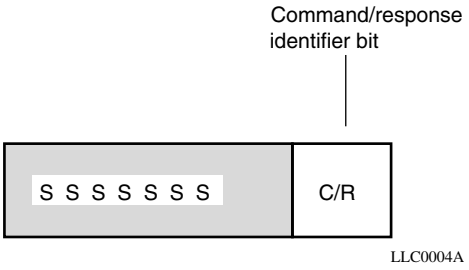

Figure 1-5. SSAP Address Field

A value of 0 for the command/response identifier bit indicates that the PDU is a Command PDU.

A value of 1 for the command/response identifier bit indicates that the PDU is a Response PDU.

SAP Addressing Scheme

All of the 802.2/LLC protocols provide a SAP addressing scheme that lets multiple applications and protocol entities in a single machine share a MAC address. Popular network protocols such as LAN Network Manager, NetBIOS, and SNA all have published SAP addresses, but any application can use a SAP to send or receive data via the LLC sublayer. The LLC SAP function sorts frames coming up from the MAC layer and directs them to the appropriate application or protocol software entity.

Figure 1-6 illustrates some SAPs published for NetBIOS and SNA. The “xx” in the last column denotes all other published and unpublished SAPs.

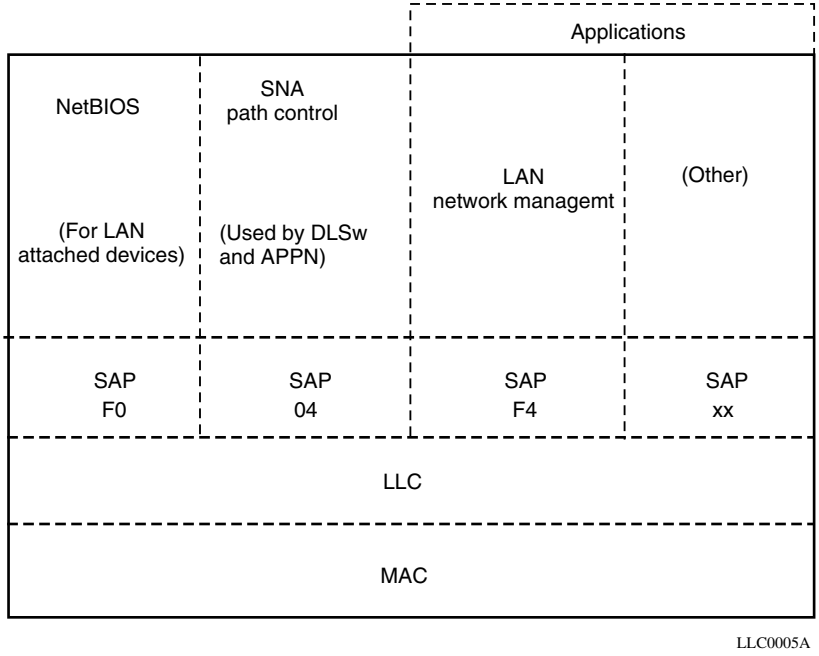

Figure 1-6. SAPs for LLC Clients

SAP addresses are as follows:

- *Individual* -- Designates a single SAP. The individual address is usable as both an SSAP and a DSAP. The individual SAP has an address designation bit value of 0.
- *Group* -- Designates a group of DSAPs. The group DSAP has an address designation bit value of 1.
- *Global* -- Designates a group consisting of all DSAPs that the underlying MAC SAP addresses actively service. The global DSAP has a value of all 1s.
- *Null* -- Designates the SAP of the underlying MAC sublayer and does not identify any SAP to either the network layer or to an associated layer management function. The null address is usable as both an SSAP and a DSAP. The null SAP has a value of all 0s.

Control Field

The control field consists of one or two octets that designate command and response functions. It also contains sequence numbers when required.

The format of the control field of the LLC PDU defines the type of operation (type 1 versus type 2):

- Information (an I format PDU)
- Supervisory (an S format PDU)
- Unnumbered (a U format PDU)

Figure 1-7 shows the three control field formats.

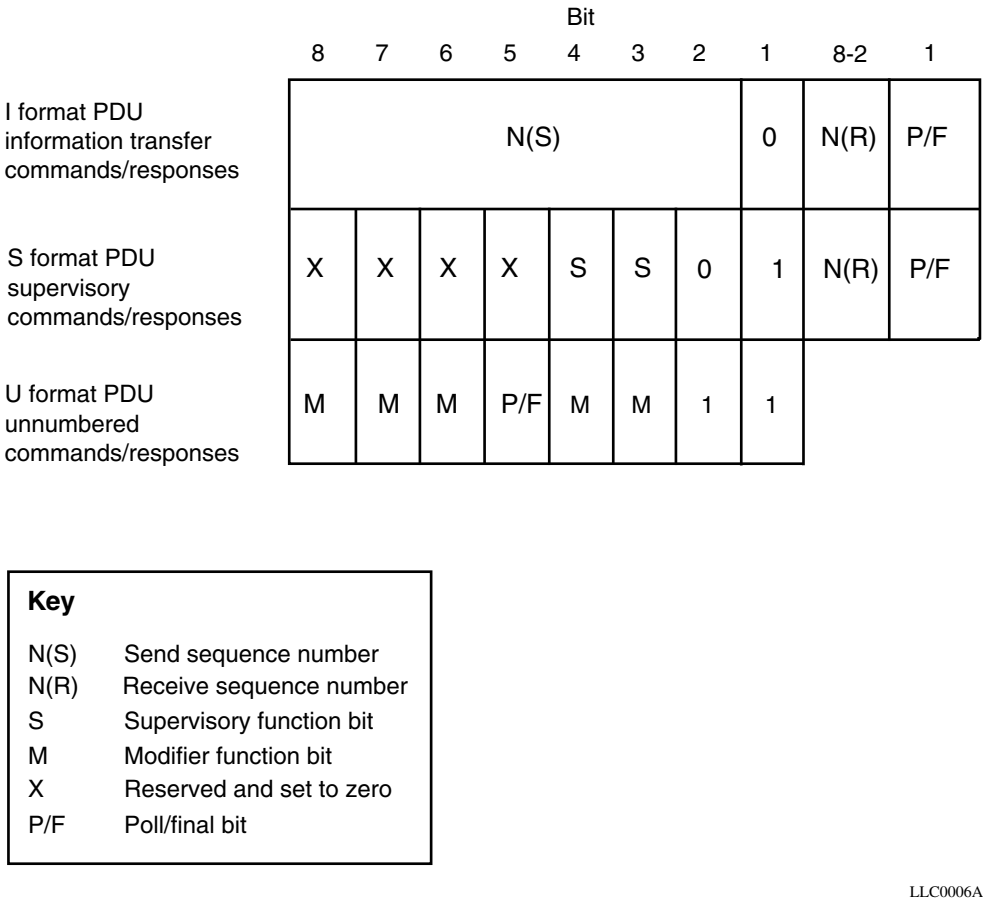
Bit
8 7 6 5 4 3 2 1 8-2 1
I format PDU information transfer commands/responses
N(S) 0 N(R) P/F
S format PDU supervisory commands/responses
X X X X S S 0 1 N(R) P/F
U format PDU unnumbered commands/responses
M M M P/F M M 1 1
Key
N(S) Send sequence number
N(R) Receive sequence number
S Supervisory function bit
M Modifier function bit
X Reserved and set to zero
P/F Poll/final bit
LLC0006A

Figure 1-7. LLC PDU Control Field Format

Control Field Formats

Table 1-2 further defines the purpose of the three PDU types, where the specific format in the PDU control field determines the type.

Table 1-2. PDU Format and Function

Format	Function
Information transfer Format (I)	The I format PDU performs a numbered information transfer in type 2 operation. Except for the UI, TEST, FRMR, and XID command/ response PDUs, the I format PDU is the only LLC PDU that can contain an information field. (Refer to "Information Field" later in this chapter for more details.)
Supervisory format (S)	The S format PDU performs data link supervisory control functions in type 2 operation, such as acknowledging I format PDUs, requesting retransmission of I format PDUs, and requesting temporary suspension of I format PDU transmission.
Unnumbered format (U)	The U format PDU is available for type 1 or type 2 operations, and provides additional data link control functions and unsequenced information transfer.

Table 1-3 further defines the purpose of parameter bits in the PDU control field.

Table 1-3. Control Field Bits and Functions

Bit	Function
Send sequence number (N [S]) bit	Only I PDUs contain N(S), which is the sequence number of the PDU being transmitted.
Receive sequence number (N [R]) bit	I PDUs contain N(R), which is the sequence number of the PDU an LLC expects to receive next on the specified data link connection.
Poll/final (P/F) bit	The P/F bit solicits (polls) a response from the addressed LLC. The final (F) bit indicates the response PDU sent as a result of a soliciting (poll) command.

Table 1-4 further defines the purpose of each command and response PDU.

Table 1-4. Command Names and Definitions

Command/ Response	Control Field Value	Definition
Unnumbered information (UI)	0x13 or 0x03	Transports information to one or more LLCs. Since this is a type 1 operation, there is no corresponding response/reply PDU.
Exchange identification (XID)	0xBF or 0xAF	The XID command PDU conveys to the destination LLC: • The types of LLC services the source LLC supports • The receive window size the source LLC supports per data link connection (per virtual circuit) The XID response PDU identifies the responding LLC and conveys to the source LLC: • The types of LLC services the destination LLC supports • The receive window size the destination LLC supports per data link connection (per virtual circuit)
Test (TEST)	0xF3 or 0xE3	The TEST command PDU causes the destination LLC to respond with the TEST response PDU; it performs a loopback test of the LLC-to-LLC transmission paths. The TEST command PDU also initiates the establishment of an LLC1 logical link across a network to another LLC entity. The TEST response PDU confirms the establishment of an LLC1 link.

(continued)

Table 1-4. Command Names and Definitions *(continued)*

Command/ Response	Control Field Value	Definition
Information (I)	6xxx0 or xx even	The I command PDU indicates to the destination LLC: • The sequence number for each I command PDU • The I PDU sequence number the destination LLC expects next The I command PDU also serves as an I response PDU by indicating to the destination LLC that the source LLC has received I PDUs up to a designated number from that destination LLC.
Receiver ready (RR)	01xx	The RR command PDU indicates that the source LLC is ready to receive an I PDU. The sending LLC then considers I PDUs sent prior to the RR condition as acknowledged.
Receiver not ready (RNR)	05xx	The RNR command PDU notifies the destination LLC that the originating LLC is busy and temporarily unable to receive I PDUs. RNRs, combined with RRs, control flow between source and destination LLC interfaces.
Reject (REJ)	09xx	The REJ command PDU conveys a request to the peer LLC to retransmit I PDUs, starting with the I PDU that the REJ command designates.
Set asynchronous balanced mode extended (SABME)	7F or 6F	The SABME command PDU establishes an LLC2 connection to the destination LLC. The connection operates in asynchronous balanced mode. If the destination LLC receives from its network layer a data link connect request, the destination LLC responds to the SABME PDU with a UA PDU. If the destination LLC receives from its network layer a data link disconnect request, it does not send a UA PDU.

(continued)

Table 1-4. Command Names and Definitions *(continued)*

Command/ Response	Control Field Value	Definition
Disconnect (DISC)	53 or 43	The DISC response PDU closes an open connection by initiating a SABME command. The DISC PDU informs the destination LLC that the source LLC is suspending the data link connection, and the destination LLC should assume the disconnected mode. Prior to acting on the DISC command, the destination LLC must confirm the acceptance of the DISC command PDU by sending a UA response PDU. I PDUs sent previously but not acknowledged remain unacknowledged.
Unnumbered acknowledgment (UA)	73 or 63	The UA response PDU acknowledges the receipt and acceptance of a SABME or DISC command PDU relating to a specific data link connection to be opened or closed, as appropriate for the type of command PDU it has received.
Disconnected mode (DM)	1F or 0F	The DM response PDU indicates that the LLC sending the response is logically disconnected from the data link connection.
Frame reject (FRMR)	97 or 87	The FRMR command PDU reports to the sending LLC that an uncorrectable condition was detected in a received frame. The FRMR PDU includes an information field that indicates the reason for the PDU rejection. The LLC receiving the FRMR PDU responds as follows: • Initiates the appropriate mode setting • Initiates corrective action by reinitializing transmission in both directions on the data link connection, using the SABME and DISC command PDUs, as appropriate

Information Field

The contents of the information field depend on the type of PDU it appears in, as follows:

- The information field of an I format PDU contains only user data.
- The information field of a UI command/response PDU also contains only user data.
- The information field of a TEST command/response PDU is optional and contains a test pattern used for LLC loopback testing.
- The information field of an XID command/response PDU contains:
  - -- An 8-bit XID format identifier field
  - -- A 16-bit parameter field encoded to identify the LLC services supported, plus the maximum receive window size
- The information field of an FRMR PDU contains the reason for PDU rejection by an LLC. For more details on the FRMR PDU, refer to *ISO 8802/IEEE Std 802.2 1989*.

Chapter 2
LLC2 Routed over Frame Relay

LLC2 (connection-oriented service) in a Nortel Networks router supports frame relay with both data link switching (DLSw) and Advanced Peer-to-Peer Networking (APPN), based on RFC 1490.

Compatibility with RFC 1490

RFC 1490 describes an encapsulation method for carrying internetworking traffic over a frame relay backbone. The description covers both bridging and routing standards.

The Nortel Networks router implementation of LLC exceeds RFC 1490 (SNA encapsulation in frame relay only) by complying with the frame relay Forum's "Protocol Encapsulation over Frame Relay Implementation Agreements." The latter description not only defines how routed SNA traffic traverses a frame relay network, but also adds RFC 1490 support for frame relay to DLSw and APPN.

This feature allows native SNA traffic originating from SDLC-, token ring-, or Ethernet-attached devices to communicate over public or private frame relay networks directly with IBM 3745 or 3746 communications controllers. It operates on all Nortel Networks routers that include a frame relay interface. Devices can communicate with intermediate routing nodes or in a single-switch configuration similar to a standalone Frame Relay Access Device (FRAD).

Compatibility with IBM NCP 7.1 and Later

LLC2 routed over a frame relay (BNN) network is fully compatible with IBM NCP 7.1 and later, and with existing or new IBM equipment. The service has passed IBM interoperability testing. You can use it without upgrading your LAN-based downstream physical units (DSPUs) or network type, such as APPN or IP.

DSPUs attached to the router retain full visibility for IBM NetView management. The router passes through all NetView commands for the DSPUs and any alerts generated by the DSPUs.

You can configure a network without a router at the host, if the communications controller is directly attached to a frame relay network. Some terminals can also connect directly to the frame relay network without a router. Frame relay networks save the expense of leased lines. Additional savings accrue because one port on a communications controller can support hundreds of data link connection identifiers (DLCIs).

Nortel Networks interoperates with NCP 7.1 and later with software only, eliminating the need for any new hardware or upgrades to existing SNA terminals or router equipment.

Figure 2-1 illustrates the connection of an SNA host through a frame relay network in a configuration with multiprotocol traffic to other locations. In addition to APPN, token ring, and IP traffic, LLC can also route SDLC and Ethernet traffic.

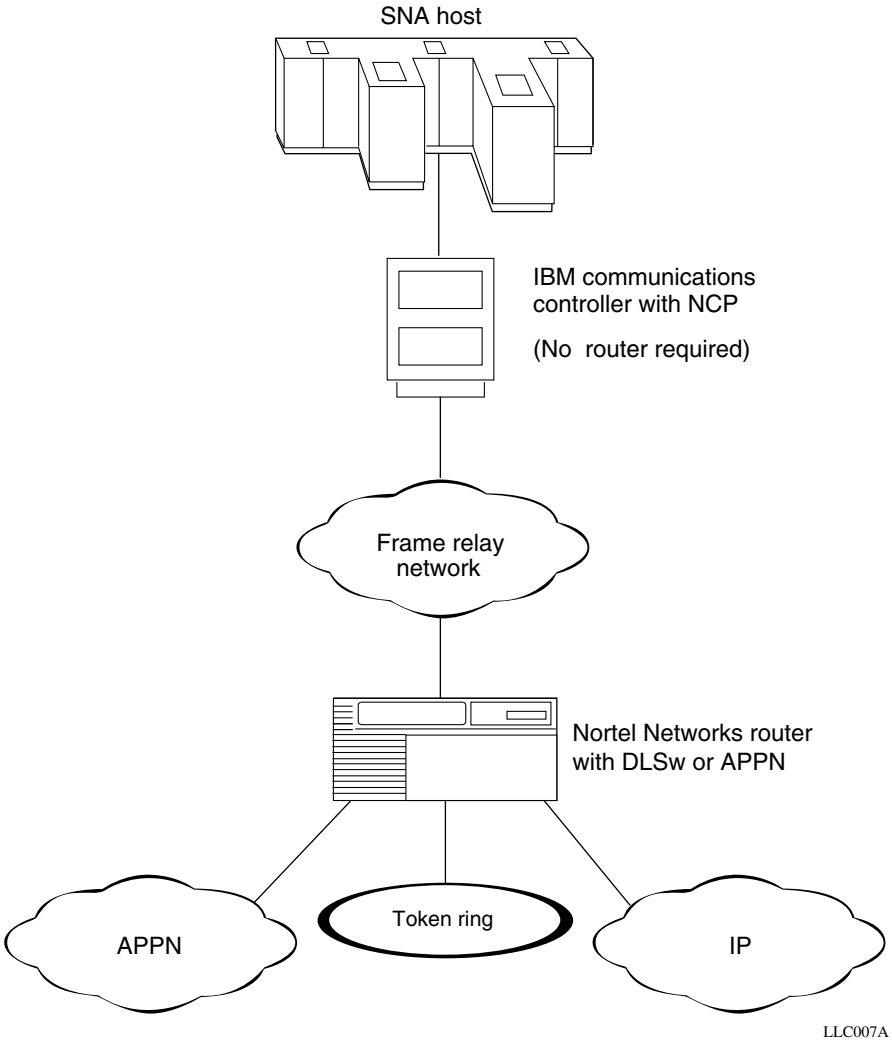

Figure 2-1. Sample Frame Relay Network Using LLC2

FRAD-like Functionality

Token ring, Ethernet, and SDLC end stations communicate with a frame relay-attached host via Frame Relay Access Devices (FRADs). The Nortel Networks router with DLSw operating in single-switch mode has FRAD-like capability, supporting token ring, Ethernet, and SDLC end stations. The router performs the following actions:

- Terminates the data link control level sessions
- Strips the link-level header off the SNA packet
- Puts an RFC1490 LLC header on the SNA packet
- Sends packets into the frame relay network

Mapping DLCIs to MAC Addresses

The frame relay network provides a number of permanent virtual circuits (PVCs) that connect devices attached to the same frame relay network. Each virtual circuit is uniquely identified at each frame relay interface by a DLCI. The frame relay interface allows either group or direct (single) assignment of DLCIs. Group assignment allows many DLCIs per circuit; direct assignment allows only one.

The system administrator or frame relay provider assigns DLCIs. To communicate with an IBM host, you must associate the MAC address of your DSPU with a DLCI. You can accomplish this task in one of two ways:

- Create a virtual MAC address, formed by preceding the DLCI address, such as 100 (decimal), with a unique mask, such as 0x400000FF, to make a valid MAC address, for example, 400000FF0064. (Decimal 100 is 64 hexadecimal.)

  When the router receives an LLC frame from the DLSw network with a destination MAC (dmac) starting with the virtual MAC mask, it can automatically translate it into a DLCI, so no mapping table is needed at the frame relay interface.

- Use the end station's physical or locally configured MAC address. In this case, be aware that if you change your hardware or end station configuration, you have to reconfigure the DLCI mapping table.

When the router receives an LLC frame from the DLSw network with a dmac not starting with the virtual MAC mask, the mapping table at the frame relay interface translates the dmac into a DLCI.

SDLC single switched over LLC does not require address mapping if a virtual MAC address is used to access the host. But you still have to define DLCIs.

Usually you configure only the remote MAC in the mapping table, setting it equal to the remote host MAC address. (A host may be an IBM mainframe.) You must configure the local MAC in the mapping table only if the frame relay interface receives connection requests. Usually only local (workstation) nodes will request a connection, so you configure only the remote MAC address.

Router Mapping Examples

Some sample network configurations with associated mapping tables follow, including:

- Virtual MAC to frame relay
- Frame relay to virtual MAC
- Physical MAC to frame relay
- Frame relay to physical MAC
- Frame relay to frame relay

Although these network configurations illustrate topologies with two routers, the same principles apply for DLSw operating in single-switch mode. Instead of configuring a single interface on each router, you configure two interfaces on a single router.

Virtual MAC to Frame Relay

Figure 2-2 illustrates a sample virtual MAC address to frame relay DLCI mapping. In this illustration, the PC makes connection requests to hosts 1 and 2. The workstation administrator has control over the PC configuration and has configured the remote host addresses as virtual MAC addresses corresponding to the DLCIs assigned to the hosts. Configuring the PC in this way simplifies the router configuration because a mapping table is not necessary in the frame relay-attached router B. The connection request received at router A will have a source MAC address of the PC MAC and a destination MAC address of remote host 1 or 2.

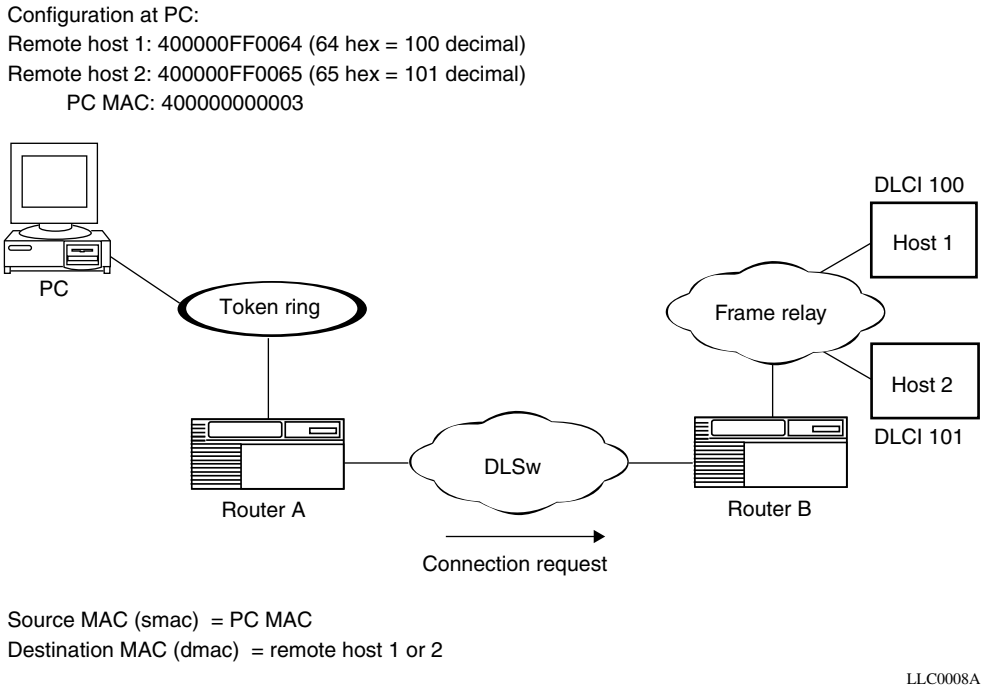

Figure 2-2. Virtual MAC to Frame Relay Topology

Frame Relay to Virtual MAC

Figure 2-3 illustrates a sample frame relay DLCI to virtual MAC address mapping. In this network, hosts 1 and 2 can make connection requests to the PC. The workstation administrator has control over the PC configuration and has configured the remote host addresses as virtual MAC addresses corresponding to the DLCIs assigned to the hosts.

At router B, a mapping table maps the hosts 1 and 2 DLCIs to the PC MAC address. Router B first creates a connection request with the source MAC addresses equal to the virtual MAC address corresponding to the hosts 1 and 2 DLCIs. Router B then creates a connection request with the destination MAC equal to the local MAC address from the mapping table.

Router B always sets the source MAC address equal to the virtual MAC address, even when a remote MAC address is configured in the mapping table.

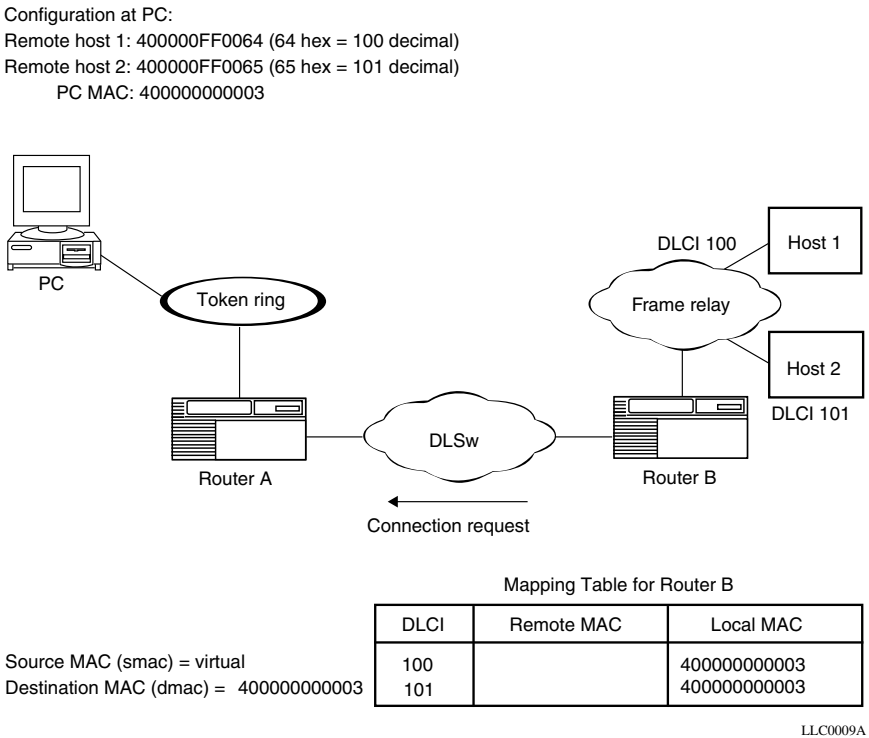

Figure 2-3. Frame Relay to Virtual MAC Topology

Physical MAC to Frame Relay

Figure 2-4 illustrates a sample physical MAC address to frame relay DLCI mapping. In this network, the PC makes connection requests to hosts 1 and 2. The workstation administrator does not have control over the PC configuration and must use a configuration with real, physical MAC addresses for the remote hosts.

At router B, a mapping table maps hosts 1 and 2 to the DLCIs assigned to the hosts. The connection request received at router A will have the source MAC address of the PC MAC, and a destination MAC address of remote host 1 or 2.

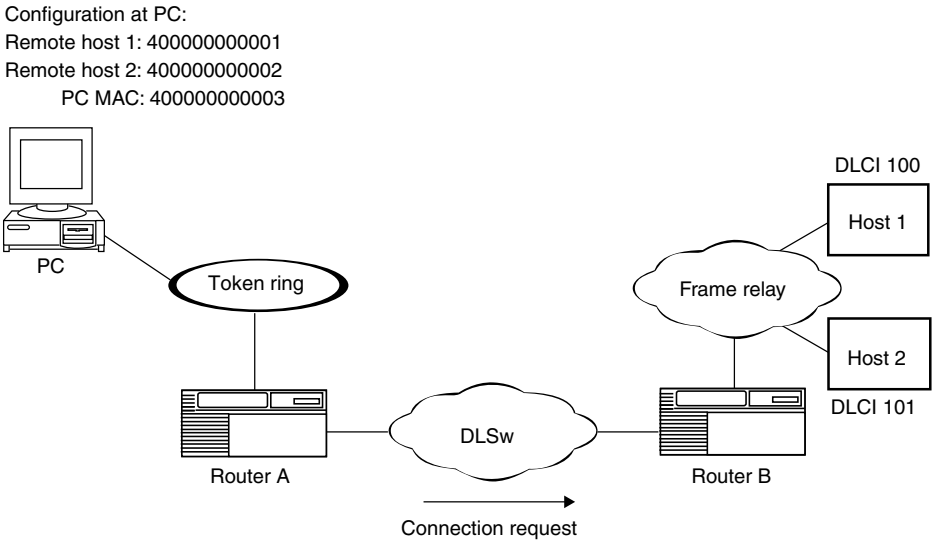

Figure 2-4. Physical MAC to Frame Relay Topology

Frame Relay to Physical MAC

Figure 2-5 illustrates a sample frame relay DLCI to physical MAC mapping. In this network, hosts 1 and 2 can make connection requests to the PC. The workstation administrator does not have control over the PC configuration and must use a configuration with real, physical MAC addresses for the remote hosts.

Router B requires a mapping table to map the hosts 1 and 2 DLCIs to the PC MAC address. Router B creates a connection request with the source MAC address equal to the virtual MAC address corresponding to the host 1 and 2 DLCIs. Router B also creates a connection request with the destination MAC address equal to the local MAC address from the mapping table.

Router B always sets the source MAC address equal to the virtual MAC address, even when a remote MAC address is configured in the mapping table.

Note: This mapping does not work with applications that check the source MAC address against configured remote host addresses.

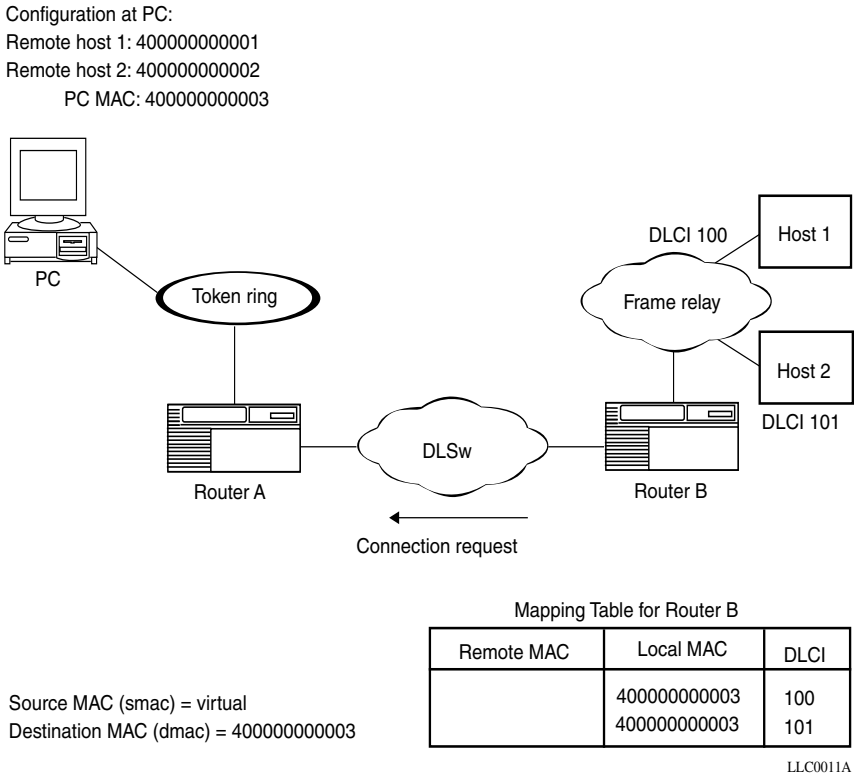

Figure 2-5. Frame Relay to Physical MAC Topology

Frame Relay to Frame Relay

Figure 2-6 illustrates a sample frame relay DLCI to frame relay DLCI mapping. In this network, the PC makes connection requests to both hosts 1 and 2. The workstation administrator has configured the PC with remote hosts 1 and 2 equal to the assigned DLCIs. Router A requires a mapping table to map the remote host 1 and 2 DLCIs to a virtual MAC address corresponding to the host 1 or 2 DLCI.

Router A creates a connection request with the source MAC address equal to the virtual MAC address corresponding to the remote host 1 or 2 DLCI. Router B creates a connection request with the destination MAC address equal to the local MAC address from the mapping table.

Router A always sets the source MAC address equal to the virtual MAC address, even if there is a remote MAC address configured in the mapping table.

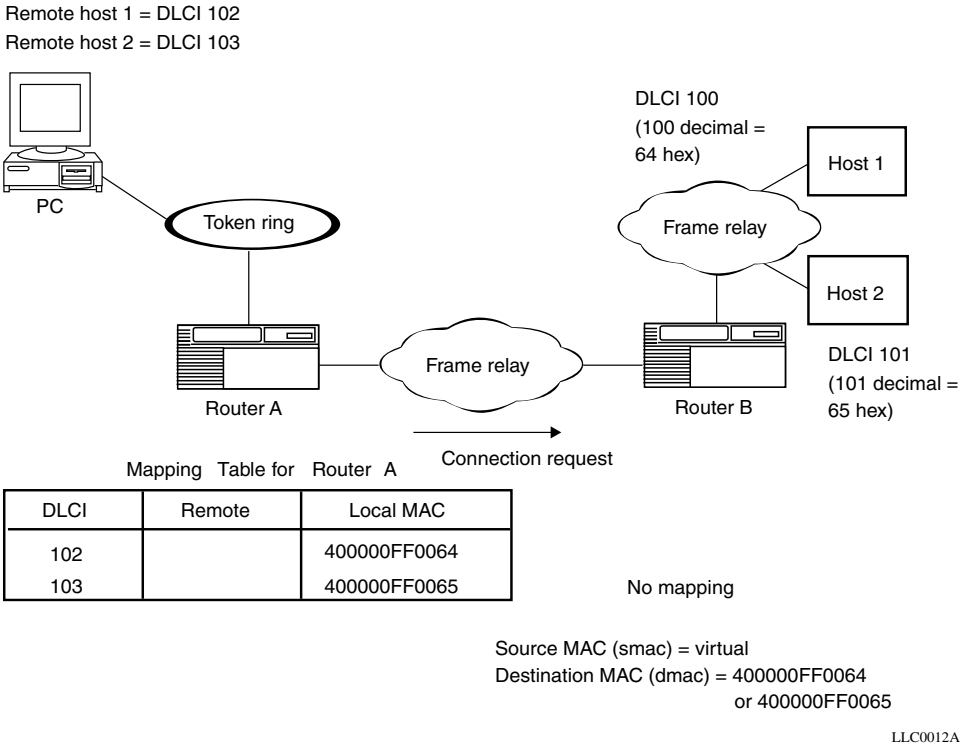

Figure 2-6. Frame Relay to Frame Relay Topology

LLC2 over Frame Relay: Routed versus Bridged

Figure 2-7 illustrates (a) SNA over frame relay with source route bridging and (b) SNA over frame relay in native mode, including routing through SDLC and Ethernet. The frame relay link can be part of an alternate route to the token ring or other link. Dotted lines indicate the path of LLC, which passes through bridging but terminates at the router for more flexible routing.

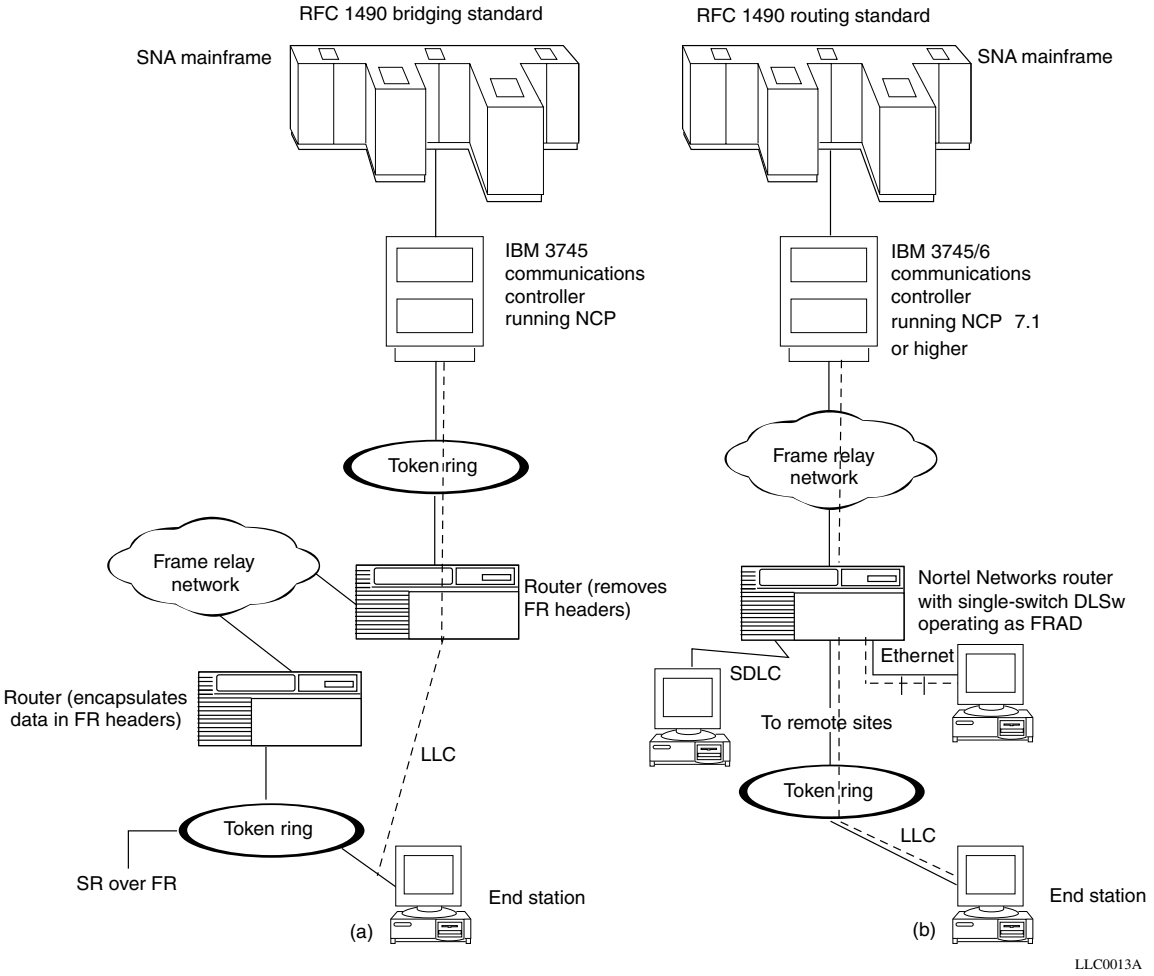

Figure 2-7. RFC 1490 Bridging and Routing Standards for SNA

Chapter 3
Starting LLC Services

This chapter describes how to create a basic LLC configuration by specifying values for required parameters only and accepting default values for all other parameters of LLC.

Topic	Page
Starting Configuration Tools	3-2
Starting LLC2 on a Router	3-4
Starting LLC2 over ATM LANE	3-7
Starting DLSw and LLC2 over Frame Relay	3-9
Starting APPN and LLC2 over Frame Relay	3-19

When you start LLC2 over frame relay with APPN and DLSw, you must specify the frame relay mapping parameters yourself, while the Configuration Manager sets default values for all the rest.

For background information about LLC, see Chapter 1. To customize LLC by changing default values, see Chapter 4. To change the default settings, see Appendix A, “Site Manager Parameters.” To obtain LLC data from the management information base (MIB), see Appendix B, “Monitoring LLC Using the BCC show Commands.”

Starting Configuration Tools

Before configuring LLC services, refer to the following user guides for instructions on how to start and use the Nortel Networks configuration tool of your choice.

Configuration Tool	User Guide
Bay Command Console (BCC)	*Using the Bay Command Console (BCC)*
Site Manager	*Configuring and Managing Routers with Site Manager*

These guides also describe generically how to create or modify a device configuration.

LLC2 Configuration Hierarchy

Figure 3-1 shows the hierarchy of LLC objects and the relationship between objects. The atm, frame relay, ethernet, token ring, and fddi objects are interfaces on which you can configure LLC.

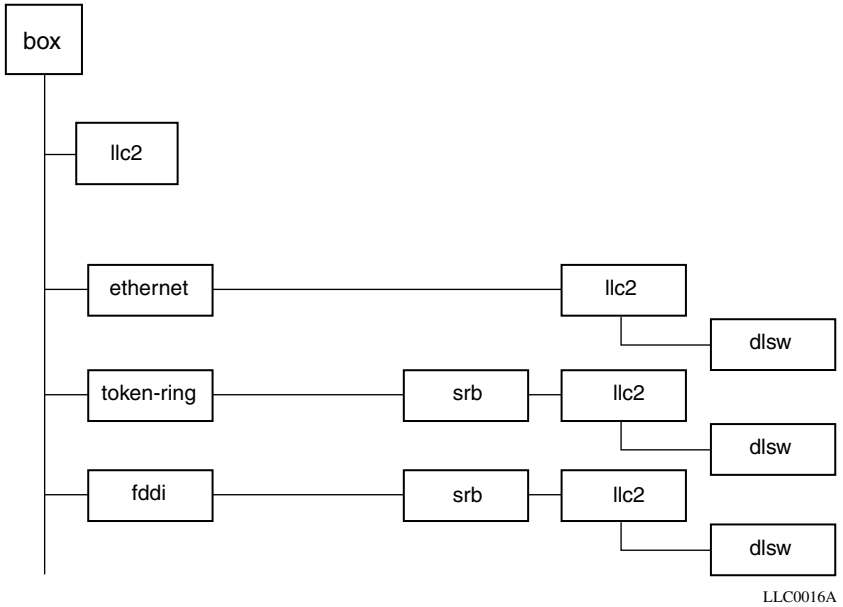

Figure 3-1. LLC2 Configuration Hierarchy *(continued next page)*

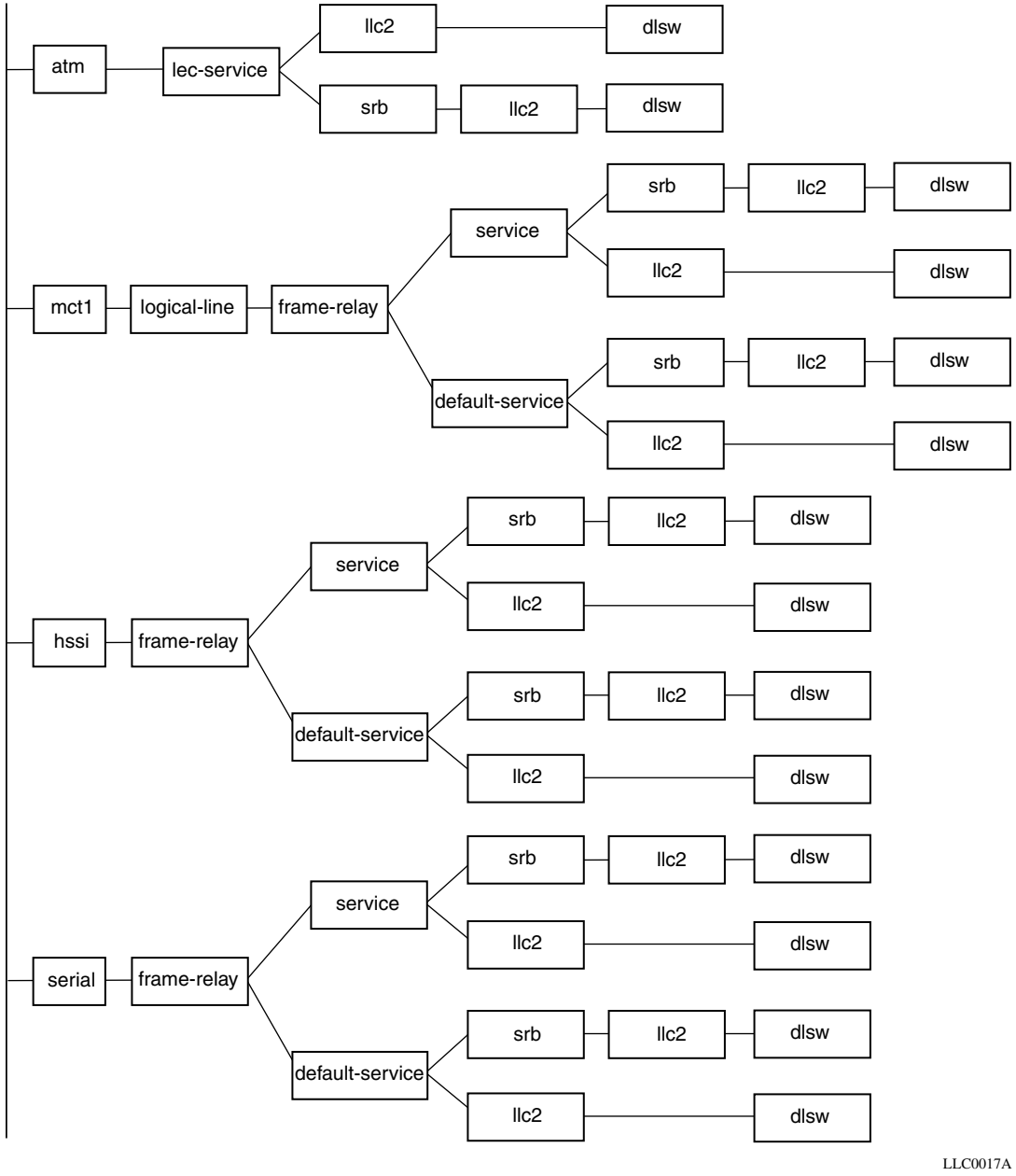

Figure 3-1. LLC2 Configuration Hierarchy *(continued)*

Starting LLC2 on a Router

With frame relay in native mode and source route bridging, you can configure only one LLC2 interface per physical circuit; with routed frame relay, you can configure more than one LLC2 interface per physical circuit, depending on your system's resources.

When you configure an LLC2 interface on an 802.*x* LAN physical (LAN-attachment) circuit, you supply information required by the MAC and LLC sublayers.

Using the BCC

The following sections describe how to configure LLC2 on the router.

Configuring LLC2 Globally

To configure LLC2 on the router with default settings, in configuration mode, navigate to the top-level box prompt:

1. **Configure LLC2.**

   ```
   box# llc2
   ```

2. **Display LLC2 default settings.**

   ```
   llc2# info
      state enabled
   ```

Configuring LLC2 on an Ethernet Interface

To configure LLC2 on an Ethernet interface with default settings, in configuration mode, navigate to the top-level box prompt:

1. **Configure an Ethernet interface. For example, enter:**

   ```
   box# ethernet slot 2 connector 1
   ethernet/2/1#
   ```

2. **Configure LLC2.**

   ```
   ethernet/2/1# llc2
   llc2/ethernet/2/1#
   ```

3. **Display LLC2 default settings.**

```
llc2/ethernet/2/1# info
   srb-ring-id 0
   fr-virtual-mask <not_set>
   max-ui-size 5128
   max-retries 2
   ui-ackwait-timer 30
   max-info-size 5128
   n2 10
   n3 1
   ack-xmt-timer 1
   reject-timer 1
   busy-timer 60
   local-response-acktimer 10
   idle-timer 120
   poll-cycle-timer 30
   max-saps 255
   max-links 255
   dup-addr-check disabled
   receive-window 7
   transmit-window 7
   encapsulation default
   dynamic-window enabled
   high-water-reset normal
   state enabled
```

Configuring LLC2 on a Token Ring Interface

To configure LLC2 on a token ring interface with default settings, in configuration mode, navigate to the top-level box prompt:

1. **Configure a token ring interface. For example, enter:**

```
box# token-ring slot 3 connector 1
token-ring/3/1#
```

2. **Configure SRB on the interface. For example, enter:**

```
token-ring/3/1# srb interface-ring-id 0x1
srb/token-ring/3/1#
```

3. **Configure LLC2.**

```
srb/token-ring/3/1# llc2
llc2/token-ring/3/1#
```

Configuring LLC2 on an FDDI Interface

To configure LLC2 on an FDDI interface with default settings, in configuration mode, navigate to the top-level box prompt:

1. **Configure an FDDI interface. For example, enter:**

```
box# fddi slot 4 connector 1
fddi/4/1#
```

2. **Configure SRB on the interface. For example, enter:**

```
fddi/4/1# srb interface-ring-id 0x1
srb/fddi/4/1#
```

3. **Configure LLC2.**

```
srb/fddi/4/1# llc2
llc2/fddi/4/1#
```

Note: LLC2 also is configured globally when you configure LLC2 on an interface.

Using Site Manager

You can easily start LLC2 services using default values for all parameters. If you decide to change some or all of the default values, see the instructions in Chapter 4.

To start LLC2 on an interface, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, select the link or network module connector on which you are enabling LLC2 services.	The Select Protocols window opens.
2. Choose **LLC2**.	The Configuration Manager window opens.

Starting LLC2 over ATM LANE

The following sections describe how to configure LLC2 over ATM LAN emulation (LANE) using the BCC or Site Manager.

Using the BCC

To configure LLC2 on an ATM LANE interface with default settings, navigate in configuration mode to the top-level box prompt:

1. **Specify the ATM interface on which you want to configure LLC2.**

   ```
   box# atm 3/1
   atm/3/1#
   ```

2. **Enable signaling on the ATM interface.**

   ```
   atm/3/1# signaling
   signaling/3/1#
   ```

3. **Return to the ATM interface prompt.**

   ```
   signaling/3/1# back
   atm/3/1#
   ```

4. **Create a LAN emulation client (LEC) service record for that interface. For example, to create a service record with the name service1, enter:**

   ```
   atm/3/1# lec-service service1
   lec-service/service1#
   ```

5. **Configure LLC2 on the ATM interface.**

   ```
   lec-service/service1# llc2
   llc2/service1#
   ```

Using Site Manager

To enable LLC2 over ATM LANE, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, select the ATM connector on which you are enabling DLSw services.	The Add Circuit window opens.
2. Click on **OK**.	The Select Connection Type window opens.
3. Click on **ATM**.	The Initial ATM Signaling Config window opens.
4. Click on **OK**.	The Edit ATM Connector window opens.
5. Click on **Service Attributes**.	The ATM Service Records List window opens.
6. Click on **Add**.	The ATM Service Record Parameters window opens.
7. Edit the parameters you want. See Appendix A in *Configuring ATM and MPLS Services* for parameter descriptions.	
8. Click on **OK**.	The Select Protocols window opens.
9. Choose **LLC2**.	
10. Click on **OK**.	The ATM Service Record Parameter window opens.
11. Click on **Done**.	The ATM Service Records List window opens.
12. Click on **Done**.	The Edit ATM Connector window opens.
13. Click on **Done**.	The Select Connection Type window opens.
14. Click on **Done**.	The Configuration Manager window opens.

Starting DLSw and LLC2 over Frame Relay

When configuring DLSw over frame relay, IBM provides two types of frame relay support:

- Boundary Access Node (BAN) -- bridged format
- Boundary Network Node (BNN) -- RFC 1490 or Routed SNA

When configuring a frame relay interface for DLSw using Site Manager, a message prompts you to select BAN PVC, BNN PVC, or BNN SVC.

Starting DLSw and LLC2 over Frame Relay BAN

BAN frames use a standard RFC 1490 Bridged 802.5 over frame relay format. Since this is a source-routed frame, you must enable SRB on a frame relay BAN interface.

The following sections describe how to configure DLSw and LLC2 over frame relay BAN using the BCC or Site Manager.

Note: If you configure two token ring interfaces or a token ring interface and a frame relay BAN interface on a DLSw single switch, the traffic between the two interfaces uses SRB, not DLSw.

Using the BCC

To configure DLSw and LLC2 on a frame relay BAN interface, you first configure SRB and DLSw global attributes. Then you configure frame relay, SRB, LLC2, and DLSw on that interface.

For example, to configure DLSw and LLC2 on a frame relay BAN interface over a serial line with default settings, navigate in configuration mode to the top-level box prompt:

1. **Configure DLSw global attributes.**

   ```
   box# dlsw
   dlsw#
   ```

2. **Specify a slot for the IP interface and the IP address to use for TCP connections based on this slot. For example, to configure slot 3 with an IP address of 1.1.1.3, enter:**

```
dlsw# slot-ip 3 ip-addr 1.1.1.3
slot-ip/3#
```

3. **Return to the box-level prompt.**

```
slot-ip/3# box
box#
```

4. **Configure SRB global attributes.**

```
box# srb internal-lan-id 0x10 bridge-id 0x15
srb#
```

5. **Return to the box-level prompt.**

```
srb# box
```

6. **Specify a serial interface on which you want to configure frame relay, SRB, LLC2, and DLSw.**

```
box# serial 3/1
serial/3/1#
```

7. **Configure frame relay on the serial interface.**

```
serial/3/1# frame-relay
frame-relay/3/1#
```

8. **Configure a service name for the frame relay interface.**

```
frame-relay/3/1# service service1
service/service1#
```

9. **Configure SRB on the serial interface.**

```
service/service1# srb interface-ring-id 0x30
srb/service1#
```

10. **Configure LLC2 on the serial interface.**

```
srb/service1# llc2
llc2/service1#
```

11. **Configure DLSw on the serial interface.**

```
llc2/service1# dlsw
dlsw/service1#
```

12. **Display DLSw default settings.**

```
dlsw/service1# info
```

Using Site Manager

When you select BAN PVC, SRB is automatically enabled and you must configure it. Specifically:

- If SRB has not been previously configured on the router, the SRB Global Parameters window appears.
- The SRB Interface Parameters window appears.

For more information about configuring SRB, see *Configuring Bridging Services*.

To enable DLSw and LLC2 over frame relay BAN, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, select the synchronous connector on which you are enabling DLSw services.	The Add Circuit window opens.
2. Click on **OK**.	The WAN Protocols window opens.
3. Choose **Frame Relay**.	
4. Click on **OK**.	The Select Protocols window opens.
5. Choose **DLSw**. When you choose DLSw, you automatically choose LLC2.	
6. Click on **OK**.	The Frame Relay/SNA Connection window opens.
7. Click on **BAN**.	The DLSw Basic Global Parameters window opens.
8. Set the following parameters: • **SR Internal LAN ID** • **DLSw Virtual Ring ID (hex)** • **DLSw RFC Version** • **DLSw Peer IP Address** (dual-switch networks only) Refer to *Configuring DLSw Services* for descriptions of the parameters.	
9. Click on **OK**.	The DLSw Basic Interface window opens.

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
10. Set **SR Interface Ring ID** and **DLSw Slot IP Address**. Refer to *Configuring DLSw Services* for descriptions of the parameters.	
11. Click on **OK**.	The Configuration Manager window opens.

Starting DLSw and LLC2 over Frame Relay BNN

Because the BNN format does not carry the destination MAC address, incoming LAN frames are delivered to the host in two ways:

- Using permanent virtual circuits (PVCs)
- Using switched virtual circuits (SVCs)

Using PVCs

If you use PVCs to connect two devices over the network, the router retrieves the destination MAC address from a frame relay mapping table. The table has these fields:

- DLCI -- Represents a frame relay PVC
- Remote MAC -- Represents the destination MAC address
- Local MAC -- Represents a source MAC address

There is one frame relay mapping table for each physical frame relay interface. Each entry must have a value specified for the Local MAC, Remote MAC, or both. Incoming LLC2 packets (such as LAN packets) are checked against the entries in this table. If a match occurs, the router forwards the frame only to the DLCI specified. If no entry is found, then the information is not forwarded out this interface as a BNN packet.

Using the BCC

To configure DLSw and LLC2 on a frame relay BNN interface using PVCs, you first configure DLSw global attributes. Then, you configure frame relay, LLC2, and DLSw on that interface.

For example, to configure DLSw and LLC2 on a frame relayBNN PVC interface over a serial line with default settings, navigate in configuration mode to the top-level box prompt:

1. **Configure DLSw global attributes.**

   ```
   box# dlsw
   dlsw#
   ```

2. **Specify a slot for the IP interface and the IP address to use for TCP connections based on this slot. For example, to configure slot 3 with an IP address of 1.1.1.3, enter:**

   ```
   dlsw# slot-ip 3 ip-addr 1.1.1.3
   slot-ip/3#
   ```

3. **Return to the box-level prompt.**

   ```
   slot-ip/3# box
   box#
   ```

4. **Specify a serial interface on which you want to configure frame relay, LLC2, and DLSw.**

   ```
   box# serial 3/1
   serial/3/1#
   ```

5. **Configure frame relay on the serial interface.**

   ```
   serial/3/1# frame-relay
   frame-relay/3/1#
   ```

6. **Configure a service name for the frame relay interface.**

   ```
   frame-relay/3/1# service service1
   service/service1#
   ```

7. **Configure LLC2 on the serial interface.**

   ```
   service/service1# llc2
   llc2/service1#
   ```

8. **Configure the number of the virtual circuit to which you are mapping the local or remote MAC address. For example:**

   ```
   llc2/service1# dlci 101
   dlci/101#
   ```

9. **Configure the remote and local MAC addresses. For example:**

   ```
   dlci/101# local-mac 111111111111 remote-mac 222222222222
   dlci/101#
   ```

10. Return to the llc2 prompt.

```
dlci/101# back
llc2/service1#
```

11. Configure DLSw on the serial interface.

```
llc2/service1# dlsw
dlsw/service1#
```

12. Display DLSw default settings.

```
dlsw/service1# info
```

Using Site Manager

To enable DLSw and LLC2 over a frame relay BNN interface using PVCs , complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, select the synchronous connector on which you are enabling DLSw services.	The Add Circuit window opens.
2. Click on **OK**.	The WAN Protocols window opens.
3. Choose **Frame Relay**.	
4. Click on **OK**.	The Select Protocols window opens.
5. Choose **DLSw**. When you choose DLSw, you automatically choose LLC2.	
6. Click on **OK**.	The Frame Relay/SNA Connection window opens.
7. Click on **BNN PVC**.	The DLSw Basic Global Parameters window opens.
8. Set the following parameters: • **DLSw Virtual Ring ID (hex)** • **DLSw RFC Version**. • **DLSw Peer IP Address** (dual-switch networks only) Refer to *Configuring DLSw Services* for descriptions of the parameters.	
9. Click on **OK**.	The DLSw Basic Interface window opens.

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
10. Set **DLSw Slot IP Address**. Refer to *Configuring DLSw Services* for a description of the parameter.	
11. Click on **OK**.	The LLC2 Frame Relay PVC Mappings window opens.
12. Click on **Add**.	The LLC2 Frame Relay PVC Mapping Add window opens.
13. Set the following parameters: • **DLCI** • **Remote MAC** • **Local MAC** Click on **Help** or see the parameter descriptions beginning on page A-7.	
14. Click on **OK**.	The LLC2 Frame Relay PVC Mappings window opens.
15. Click on **Done**.	The Configuration Manager window opens.

UsingSVCs

If you use SVCs to connect two devices over the network, it is unnecessary to preconfigure virtual circuits. An SVC exists only when there is data to transfer. For SVCs, the frame relay switch assigns the DLCI number on a per call basis.

The Destination MAC address is mapped to a data network address X.121 or E.164 number (address, subaddress, numbering plan, and type of number). You configure the numbering plan numbers (for example, X.121 or E.164). Each record contains one mapping and mapping type (either local or remote).

Remote Mapping

Use remote mapping to map a remote MAC address to a remote data network address (DNA) for outgoing calls. Local mapping maps the called DNA in the incoming setup message to the local MAC address.

If you configure only the remote mappings, then the router can only initiate an SVC setup because the router cannot accept incoming calls. The router accepts incoming calls from any MAC address to the destination MAC address configured in the mapping and establishes the SVC.

Local Mapping

The router accepts the local DNA from the Frame Relay Service Record SVC configured in the mapping and establishes the SVC. The local DNA from the Frame Relay Service Record SVC configuration serves as the source DNA. If you configure only the local mappings, then the router cannot initiate the calls; it can only accept incoming calls. If you configure local and remote mappings, then the router can initiate and accept the call for the connection.

Using the BCC

To configure DLSw and LLC2 on a frame relay BNN interface using SVCs, you first configure DLSw global attributes. Then, you configure frame relay, LLC2, and DLSw on that interface.

For example, to configure DLSw and LLC2 on a frame relay BNN SVC interface over a serial line with default settings, navigate in configuration mode to the top-level box prompt:

1. **Configure DLSw global attributes.**

   ```
   box# dlsw
   dlsw#
   ```

2. **Specify a slot for the IP interface and the IP address to use for TCP connections based on this slot. For example, to configure slot 3 with an IP address of 1.1.1.3, enter:**

   ```
   dlsw# slot-ip 3 ip-addr 1.1.1.3
   slot-ip/3#
   ```

3. **Return to the box-level prompt.**

   ```
   slot-ip/3# box
   box#
   ```

4. **Specify a serial interface on which you want to configure frame relay, SRB, LLC2, and DLSw.**

   ```
   box# serial 3/1
   serial/3/1#
   ```

5. **Configure frame relay on the serial interface.**

```
serial/3/1# frame-relay
frame-relay/3/1#
```

6. **Configure a service name for the frame relay interface.**

```
frame-relay/3/1# service service1
service/service1#
```

7. **Configure an SVC on the service record.**

```
service/4/1# svc-options svc-name svc1
svc-options/svc1#
```

8. **Configure LLC2 on the serial interface.**

```
service/service1# llc2
llc2/service1#
```

9. **Configure the MAC address you want the SVC to use.**

```
llc2/service1# fr-svc 111111111111
fr-svc/111111111111#
```

10. **Return to the llc2 prompt.**

```
fr-svc/111111111111# back
llc2/service1#
```

11. **Configure DLSw on the serial interface.**

```
llc2/service1# dlsw
dlsw/service1
```

12. **Display DLSw default settings.**

```
dlsw/service1# info
```

Using Site Manager

To enable DLSw and LLC2 over frame relay BNN using SVCs, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, select the synchronous connector on which you are enabling DLSw services.	The Add Circuit window opens.
2. Click on **OK**.	The WAN Protocols window opens.
3. Choose **Frame Relay**	
4. Click on **OK**.	The Select Protocols window opens.
5. Choose **DLSw**. When you choose DLSw, you automatically choose LLC2.	
6. Click on **OK**.	The Frame Relay/SNA Connection window opens.
7. Click on **BNN SVC**.	The DLSw Basic Global Parameters window opens.
8. Set the following parameters: • **DLSw RFC Version** • **DLSw Virtual Ring ID (hex)** • **DLSw Peer IP Address** (dual-switch networks only) Refer to *Configuring DLSw Services* for descriptions of the parameters.	
9. Click on **OK**.	The DLSw Basic Interface window opens.
10. Set **DLSw Slot IP Address**. Refer to *Configuring DLSw Services* for a description of the parameter.	
11. Click on **OK**.	The LLC2 Frame Relay SVC Mappings window opens.
12. Click on **Add**.	The LLC2 Frame Relay SVC Mapping Add window opens.

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
13. Set the following parameters: • **MAC Address** • **Mapping Type** • **X121 Addr** • **SubAddrpage A-5** • **Numbering Plan** • **Type of Number** Click on **Help** or see the parameter descriptions beginning on page A-2.	
14. Click on **OK**.	The LLC2 Frame Relay SVC Mappings window opens.
15. Click on **Done**.	The Configuration Manager window opens.

Starting APPN and LLC2 over Frame Relay

To start APPN and LLC2 over frame relay, complete the following steps:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, select the synchronous connector on which you are enabling APPN.	The Add Circuit window opens.
2. Click on **OK**.	The WAN Protocols window opens.
3. Choose **Frame Relay**.	
4. Click on **OK**.	The Select Protocols window opens.
5. Choose **APPN**. When you choose APPN, you automatically choose LLC2.	
6. Click on **OK**.	The Source Route Encapsulation dialog box opens.
7. Click on **Cancel**. This selects native (routed) frame relay for LLC2.	The APPN Local Node Name Configuration window opens.

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
8. Set the **APPN Local Node Name** parameter. Refer to *Configuring APPN Services* for a description of the parameter.	
9. Click on **OK**.	The APPN/FR Configuration window opens.
10. Set the **DLCI** and **SAP** parameters. Refer to *Configuring APPN Services* for descriptions of the parameters.	
11. Click on **OK**.	The Configuration Manager window opens.

Chapter 4
Customizing LLC Services

When you start LLC on the router, default values are in effect for all parameters. Depending on the requirements of your network, you may want to change some of these values. This chapter includes the following information:

Topic	Page
Disabling and Reenabling LLC2 on the Router	4-1
Customizing an LLC2 Interface	4-2
Configuring LLC2 Inbound Traffic Filters	4-16
Deleting LLC2 from an Interface	4-16
Deleting LLC2 from the Router	4-18

Disabling and Reenabling LLC2 on the Router

When you configure LLC2, all LLC2 default parameter are automatically enabled on the router. If you disable LLC2, it is no longer available on the router.

Using the BCC

To disable LLC2 on the router, navigate to the llc2 global prompt and enter:

disable

For example, the following command line disables LLC2 on the router:

```
llc2# disable
llc2#
```

To reenable LLC2, navigate to the llc2 prompt and enter:

enable

For example, this command line reenables LLC2 on the router:

```
llc2# enable
llc2#
llc2# info
   state enabled
```

Using Site Manager

To disable or reenable LLC2 on the router, complete the following task:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Global**.	The Edit LLC2 Global Parameters window opens.
4. Set the **Enable** parameter. Click on **Help** or see the parameter description on page A-10	
5. Click on **OK**.	The Configuration Manager window opens.

Customizing an LLC2 Interface

You customize LLC2 interface parameters for specific clients such as DLSw and LAN Network Manager (LNM). You can configure these and other LLC2 clients on the same physical circuits and, therefore, they can share the same LLC interfaces. In such cases, you can devise a profile of LLC2 parameter settings that satisfy the combined recommendations of the LLC2 clients.

Disabling and Reenabling an LLC2 Interface

The following sections describe how to disable and enable LLC on an interface using the BCC or Site Manager.

Using the BCC

To disable or reenable LLC2 on an interface, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter the following command:

disable

For example, to disable LLC2 on an Ethernet interface, enter:

```
llc2/ethernet/2/1# disable
ethernet/2/1#
```

Using Site Manager

To enable LLC2 on a router interface, complete the following task:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Enable** parameter. Click on **Help** or see the parameter description on page A-10.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Configuring the Window Size

In LLC, a window controls how many frames a link station sends before receiving an acknowledgment. Window size depends on which modulo your network's implementation of LLC uses. Modulo 8 operation allows a maximum window size of 7; Modulo 128, a maximum of 127.

For example, with a window size of 7, a link station can transmit frames 0 through 6 before requiring acknowledgment from the receiving station. The sending station will not send more frames until it receives an acknowledgment.

Specifying the Maximum Number of Received Information PDUs

The following sections describe how to specify the maximum number of information PDUs that LLC can receive using the BCC or Site Manager.

Using the BCC

To specify the maximum number of unacknowledged information PDUs that LLC can receive, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter:

receive-window <*pdus*>

pdus is the maximum number of unacknowledged information PDUs that LLC can receive. The values are 1 to 127.

For example, the following command changes the maximum number of unacknowledged information PDUs to 10:

```
llc2/ethernet/2/1# receive-window 10
```

Using Site Manager

To specify the maximum number of unacknowledged information PDUs that LLC can receive, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Receive Window** parameter. Click on **Help** or see the parameter description on page A-13.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Specifying the Maximum Number of Outstanding Information PDUs

The following sections describe how to specify the maximum number of information PDUs that can be outstanding at any given time using the BCC or Site Manager.

Using the BCC

To specify the maximum number of information PDUs that can be outstanding (sent or transmitted) at any given time, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter:

transmit-window <*pdus*>

pdus is the maximum number of information PDUs that can be outstanding at any given time. The value serves as a default Send Window size when no other size has been set by an XID information-exchange procedure. The values are 1 to 127.

For example, the following command changes the maximum number of outstanding information PDUs to 10:

```
llc2/ethernet/2/1# transmit-window 10
```

Using Site Manager

To specify the maximum number of information PDUs that can be outstanding at any given time, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Send Window** parameter. Click on **Help** or see the parameter description on page A-14.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Specifying the Unnumbered Information and the Information PDU Size

The following sections describe how to specify the UI and I PDU size using the BCC or Site Manager.

Using the BCC

To specify the UI and I PDU size, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter the following parameters:

max-ui-size <*ui_size*> **max-info-size** <*info_size*>

ui_size is the maximum size, in octets, of an unnumbered information PDU this LLC2 interface sends or receives. The values are 1 to 5128.

info_size is the maximum size, in octets, of an information PDU this LLC2 interface sends or receives. The values are 1 to 5128.

For example, the following command changes the maximum size of the UI and I PDU to 4000 and 3000, respectively:

```
llc2/ethernet/2/1# max-ui-size 4000 max-info-size 3000
```

Using Site Manager

To specify the UI and I PDU size, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Max Octets in UI** and the **Max Octets in I** parameters. Click on **Help** or see the parameter descriptions beginning on page A-12.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Configuring Timers

Four timers control how many seconds the local LLC waits to receive the following data:

- Acknowledgment for an outstanding PDU
- Reply to a frame-reject response PDU
- Indication from a remote LLC that it is ready to receive PDUs
- PDU soliciting the status of the remote LLC

Using the BCC

To configure the LLC2 timers, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter the following parameters:

ack-xmt-timer <*seconds*> **reject-timer** <*seconds*> **busy-timer** <*seconds*> **poll-cycle-timer** <*seconds*>

For ack-xmt-timer, *seconds* is 1 to 15; for reject-timer and poll-cycle-timer, *seconds* is 1 to 30; for busy-timer, *seconds* is 1 to 60.

For example, the following command changes the values for the ack-xmt-timer and reject timer to 5, and the values for the busy-timer and the poll-cycle-timer to 25:

```
llc2/ethernet/2/1# ack-xmt-timer 5 reject-timer 5 busy-timer 25
poll-cycle-timer 25
```

Using Site Manager

To configure these timers, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Ack Timer for Xmt**, **Reject Timer**, **Busy Timer**, or **Inactivity Timer** parameters. Click on **Help** or see the parameter descriptions beginning on page A-15.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Specifying the Maximum Number of PDU Retries After Timeout

The following sections describe how to specify the maximum number of times that a PDU can be sent following expiration of a transmit acknowledgment or reject timer. You can complete these tasks using the BCC or Site Manager.

Using the BCC

To specify the maximum number of times that a PDU can be sent following expiration of the transmit acknowledgment timer or the reject timer, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter:

n2 <*number_of_retransmissions*>

number_of_retransmissions is the maximum number of times that a PDU can be sent following expiration of the ack-xmt-timer or the reject-timer. The values are 1 to 10.

For example, the following command changes the maximum number of times to 5:

```
llc2/ethernet/2/1# n2 5
```

Using Site Manager

To specify the maximum number of times that a PDU can be sent following the expiration of the Ack Timer for Xmt or the Reject Timer, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
5. Set the **Max Retry After TimeOut** parameter. Click on **Help** or see the parameter description on page A-14.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Setting the Maximum Number of LLC2 Interface Connections

The following sections describe how to set the maximum number of LLC2 interface connections using the BCC or Site Manager.

Using the BCC

To specify the maximum number of logically independent, end-to-end connections that the local LLC2 interface can allocate, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter:

max-links <*max_links*>

max-links is the number of end-to-end connections, from 4 to 5000.

For example, the following command changes the number of end-to-end connections to 1000:

```
llc2/ethernet/2/1# max-links 1000
```

Using Site Manager

To specify the maximum number of logically independent, end-to-end connections the local LLC2 interface can allocate, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Max Links** parameter. Click on **Help** or see the parameter description on page A-17.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Customizing LLC2 over Frame Relay

The following section describes how to customize LLC2 over frame relay using the BCC or Site Manager.

Configuring the Frame Relay Virtual MAC Address Mask

The frame relay virtual MAC address mask specifies the upper 2 to 4 bytes of a virtual destination MAC address. The lower remaining bytes specify the DLCI to be used.

Using the BCC

To configure the frame relay virtual MAC address mask, navigate to the llc2 interface prompt (for example, **box**; **serial 2/1**; **llc2**) and enter:

fr-virtual-mask *<mask>*

mask specifies the upper 2 to 4 bytes of a virtual destination MAC address. The lower remaining bytes specify the DLCI to be used. Select a mask that is unique within your network. The mask should be the upper 2 to 4 bytes of a standard MSB token ring MAC address.

For example, to set a mask of 0x400000FF, enter:

```
llc2/serial/1/2# fr-virtual-mask 0x400000FF
llc2/serial/1/2#
```

Using Site Manager

To configure the frame relay virtual MAC address mask, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	
5. Set the **Frame Relay Virtual MAC Address Mask** parameter. Click on **Help** or see the parameter description on page A-18.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Editing Frame Relay PVC Mappings

Using the BCC

To edit frame relay mappings that you previously configured, navigate to the llc2 dlci interface prompt (for example, **box**; **serial 2/1**; **llc2**; **dlci** *<dlci_no.>*) and enter:

local-mac *<local_mac>* **remote-mac** *<remote-mac>*

local_mac is the local MAC address, mapping incoming requests on this DLCI to that address. The local MAC address must be unique, with only DLCI mapping for a specific MAC address. *local_mac* is a standard MSB token ring MAC address.

remote_mac is the remote MAC address, mapping outgoing requests to the DLCI value. The remote MAC address must be unique, with only DLCI mapping for a specific MAC address. *remote_mac* is a standard MSB token ring MAC address.

For example, the following command changes the local and remote mac addresses to 111111111111 and 222222222222, respectively:

```
dlci/101# local-mac 111111111111 remote-mac 222222222222
dlci/101#
```

Using Site Manager

To edit and delete frame relay PVC mappings that you previously configured, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Frame Relay Mapping**.	The LLC Frame Relay PVC Mappings window opens.
4. Click on the interface you want to customize.	
5. Set the **Remote MAC** and the **Local MAC** parameters. Click on **Help** or see the parameter descriptions beginning on page A-6.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Editing Frame Relay SVC Mappings

Using the BCC

To edit frame relay SVC mappings that you previously configured, navigate to the llc2 fr-svc interface prompt (for example, **box**; **serial 2/1**; **llc2**; **fr-svc** *<mac_addr.>*) and enter one or more of the following parameters:

mapping-type *<map_type>*

map_type specifies whether this is a remote or local mapping.

sub-addr *<sub_addr>*

sub_addr specifies the outbound calling or called party subaddress, which is also the inbound calling or called party subaddress.

svc-plan *<svc_plan>*

svc_plan specifies whether this SVC uses the E.164 or X.121 number plan for addresses. The values are e164 and x121. The default is x121.

type-of-number *<no._type>*

no._type specifies the type of number the remote or local caller uses. The values are international and unknown. The default is international.

x121-addr *<x121_addr>*

x121_addr specifies a WAN address that is registered with frame relay to accept an incoming call if the mapping is local, or to establish an SVC to the configured number if the mapping is remote.

For example, the following command changes the mapping type from local to remote:

```
fr-svc/123456789012# mapping-type remote
fr-svc/123456789012#
```

Using Site Manager

To edit and delete frame relay SVC mappings that you previously configured, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Frame Relay SVC Mapping**.	The LLC Frame Relay SVC Mappings window opens.
4. Click on the interface you want to customize.	
5. Set the parameters you want. Click on **Help** or see the parameter descriptions beginning on page A-5.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Configuring the LLC Virtual Ring Number for APPN with SRB

To specify a ring number for LLC to use if you configure APPN with source route bridging, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Click on the interface you want to customize.	

(continued)

Site Manager Procedure *(continued)*	
You do this	**System responds**
5. Set the **Virtual Ring Number** parameter. Click on **Help** or see the parameter description on page A-18.	
6. Click on **Apply**.	
7. Click on **Done**.	The Configuration Manager window opens.

Configuring LLC2 Inbound Traffic Filters

For descriptive and procedural information on inbound traffic filters for LLC and any other protocols that support this capability, refer to *Configuring Traffic Filters and Protocol Prioritization*.

Deleting LLC2 from an Interface

The following sections describe how to remove LLC2 from an interface using the BCC or Site Manager.

Using the BCC

To delete LLC2 from a router interface, navigate to the llc2 interface prompt (for example, **box**; **ethernet 2/1**; **llc2**) and enter:

delete

For example, the following command removes LLC2 from a router interface:

```
llc2/ethernet/2/1# delete
ethernet/2/1#
```

Using Site Manager

To delete an LLC2 interface from its associated physical circuit, complete the following tasks:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Interfaces**.	The LLC2 Interface Configuration window opens.
4. Choose the LLC2 interface you want to delete.	
5. Click on **Delete**. The system software deletes the LLC2 entry you selected, and the entry disappears from the list of LLC2 interfaces.	
6. Click on **Done**.	The Configuration Manager window opens.

Deleting LLC2 from the Router

The following sections describe how to remove LLC2 from a router entirely using the BCC or Site Manager.

Using the BCC

To delete LLC2 services from the router entirely, navigate to the llc2 global prompt and enter:

delete

For example, the following command removes LLC2 from the router:

```
llc2# delete
box#
```

Using Site Manager

To delete LLC2 from a router entirely:

Site Manager Procedure	
You do this	**System responds**
1. In the Configuration Manager window, choose **Protocols**.	The Protocols menu opens.
2. Choose **LLC2**.	The LLC2 menu opens.
3. Choose **Delete LLC2**.	A confirmation window opens.
4. Click on **OK**.	The Configuration Manager window opens.

Appendix A
Site Manager Parameters

This appendix describes configurable LLC service parameters. The parameter descriptions follow the same order as the parameters appearing in the Site Manager windows. Table A-1 shows how the parameters are organized.

Table A-1. Organization of Parameters

Parameter Section	Page
Accessing LLC Parameters	A-2
Add LLC2 Frame Relay SVC Mappings Parameters	A-2
LLC2 Frame Relay SVC Mappings Parameters	A-5
Add LLC2 Frame Relay PVC Mappings Parameters	A-6
LLC2 Frame Relay PVC Mappings Parameters	A-8
LLC2 Global Parameters	A-9
LLC2 Interface Parameters	A-10

Using the Parameter Descriptions

Each LLC parameter description provides information about default settings, valid parameter options, the parameter function, instructions for setting the parameter, and the management information base (MIB) object ID.

The Technician Interface allows you to modify parameters by issuing **set** and **commit** commands with the MIB object ID. This process is equivalent to modifying parameters using Site Manager. For more information about using the Technician Interface to access the MIB, see *Using Technician Interface Software*.

Caution: The Technician Interface does not verify that the value you enter for a parameter is valid. Entering an invalid value can corrupt your configuration.

Accessing LLC Parameters

To access and edit LLC parameters, begin at the Configuration Manager window and select Protocols > LLC2. The LLC2 menu opens.

Alternatively, you can access LLC parameter windows by highlighting a circuit in the Configuration Manager window, and then selecting Edit Circuit to invoke the Circuit Definition window. This window is described in *Configuring and Managing Routers with Site Manager.* Use the LLC Circuit menu to access LLC parameters.

You can select either LLC1 Circuit or LLC2 Circuit from either menu. If you select LLC1 from the menu, the screen displays a list of interfaces that use LLC1 only (such as source routing bridge). If you select LLC2, the screen displays a list of interfaces that require the services of LLC2 (such as APPN, DLSw, and LNM servers).

Add LLC2 Frame Relay SVC Mappings Parameters

The LLC2 Frame Relay SVC Mapping Add window (Figure A-1) contains the following parameters:

- MAC Address -- address of the end station to be mapped
- Mapping Type -- specifies whether this is a remote or local mapping
- X121 Addr -- address that is registered with frame relay to accept an incoming call if the mapping is local, or to establish an SVC to the configured number if the mapping is remote
- Sub Addr -- outbound or inbound calling or called party subaddress

- Numbering Plan -- specifies whether this SVC uses the E.164 or X.121 number plan for address
- Type of Number -- specifies the type of number the remote or local caller uses

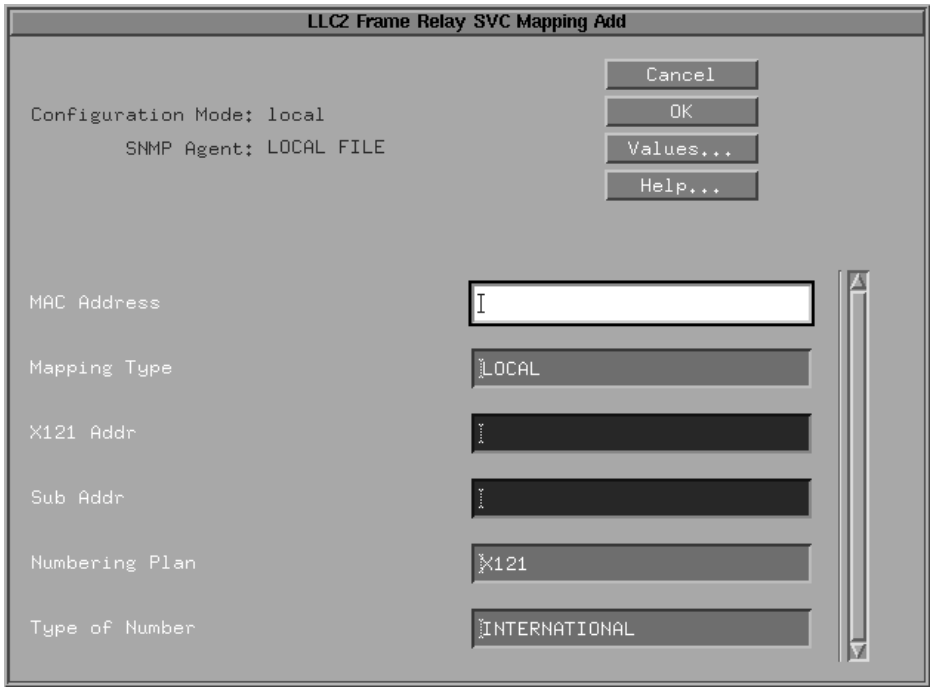

Figure A-1. LLC2 Frame Relay SVC Mapping Add Window

Parameter: MAC Address

Path: Configuration Manager > Protocols > LLC2 > Frame Relay SVC Mappings...
Default: None
Options: Standard MSB Token Ring MAC addresses
Function: Specifies the local or remote MAC address of the end station to be mapped.
Instructions: Enter the MAC address you want to use.
MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.10.1.3

Parameter: Mapping Type

Path: Configuration Manager > Protocols > LLC2 > Frame Relay SVC Mappings...
Default: Local
Options: Local | Remote
Function: Specifies whether this is a remote or local mapping.
Instructions: Accept the default, Local, or choose Remote.
MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.10.1.4

Parameter: X.21 Addr

Path: Configuration Manager > Protocols > LLC2 > Frame Relay SVC Mappings...
Default: None
Options: Any display string.
Function: Specifies a WAN address (e.g., X.121, E.164) that is registered with frame relay to accept an incoming call if the mapping is local, or to establish an SVC (initiate the call) to the configured number if the mapping is remote.
Instructions: Enter the X.21 address you want.
MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.10.1.5

Parameter: Sub Addr

Path: Configuration Manager > Protocols > LLC2 > Frame Relay SVC Mappings...
Default: None
Options: Any display string.
Function: Specifies the outbound calling or called party subaddress, which is also the inbound calling or called party subaddress.
Instructions: Enter the number.
MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.10.1.6

Parameter:	**Numbering Plan**
Path:	Configuration Manager > Protocols > LLC2 > Frame Relay SVC Mappings...
Default:	X.121
Options:	E.164 | X.121
Function:	Specifies whether this SVC uses the E.164 or X.121 number plan for addresses.
Instructions:	Choose the numbering plan that applies to your network.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.10.1.7

Parameter:	**Type of Number**
Path:	Configuration Manager > Protocols > LLC2 > Frame Relay SVC Mappings...
Default:	International
Options:	Unknown | International
Function:	Specifies the type of number the remote or local caller uses.
Instructions:	To allow the caller to use an international type, accept the default, International. Otherwise, choose Unknown.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.10.1.8

LLC2 Frame Relay SVC Mappings Parameters

The LLC2 Frame Relay SVC Mappings window (Figure A-2) allows you to edit and delete frame relay SVC mappings that you previously configured.

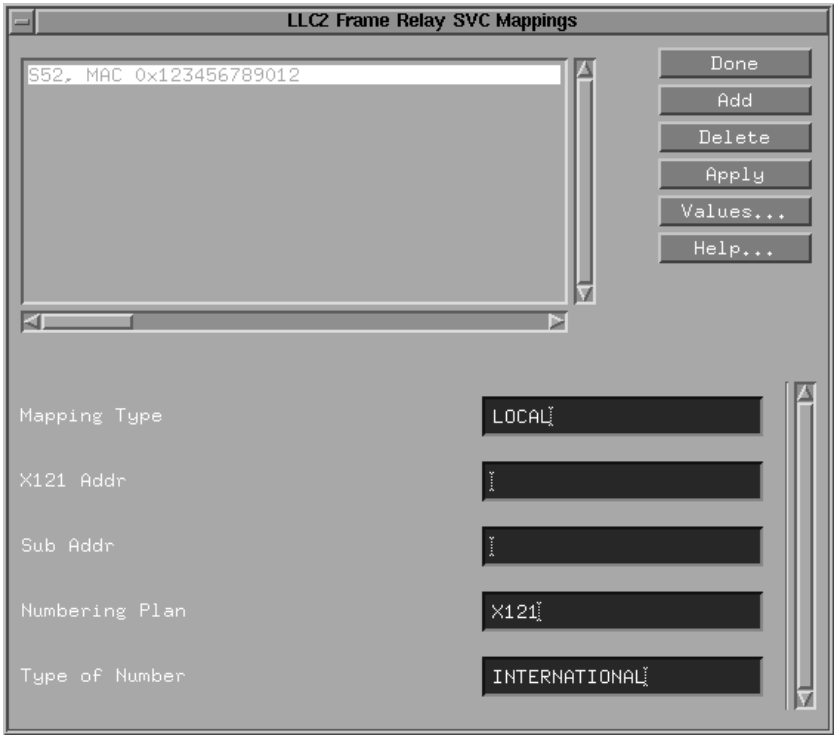

Figure A-2. LLC2 Frame Relay SVC Mappings

Add LLC2 Frame Relay PVC Mappings Parameters

The LLC2 Frame Relay PVC Mapping Add window (Figure A-3) contains the following parameters:

- DLCI -- number of the virtual circuit to which you map the local or remote MAC address
- Remote MAC -- address that maps outgoing requests to the DLCI value
- Local MAC -- address that maps incoming requests on this DLCI to this address

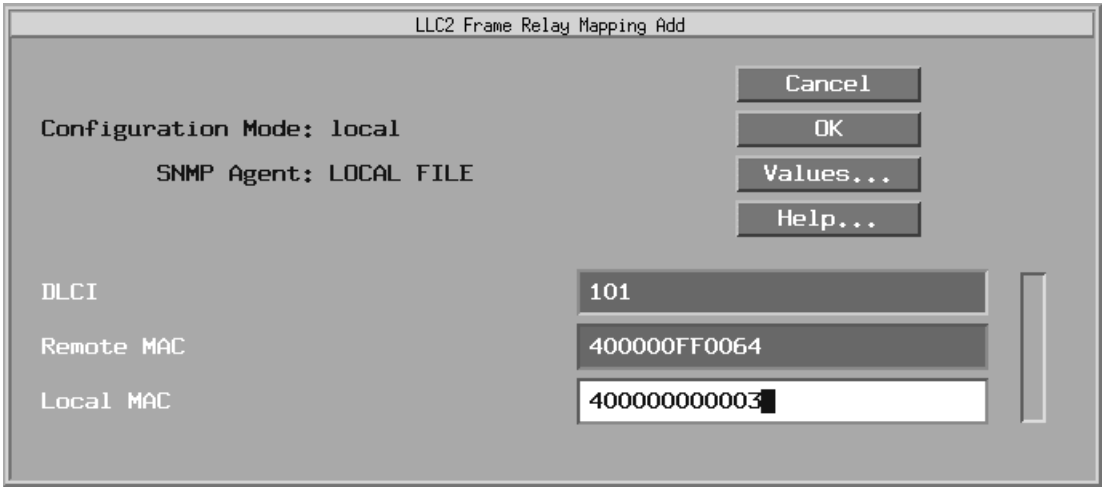

Figure A-3. LLC2 Frame Relay PVC Mapping Add Window

Parameter: DLCI

Path: Configuration Manager > Protocols > LLC2

Default: None

Options: Standard Data Link Connection Identifier numbers

Function: Provides the number of the virtual circuit to which you are mapping the local or remote MAC address.

Instructions: Enter a decimal DLCI number assigned by your system administrator or frame relay provider.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.9.1.3

Parameter:	**Remote MAC**
Path:	Configuration Manager > Protocols > LLC2 > Frame Relay Mapping
Default:	None
Options:	Standard MSB Token Ring MAC addresses
Function:	Provides the remote MAC address, mapping outgoing requests to the DLCI value. The remote MAC address must be unique, with only DLCI mapping for a specific MAC address.
Instructions:	If you need to specify the real hardware address of the host, enter it as an octal string.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.9.1.5

Parameter:	**Local MAC**
Path:	Configuration Manager > Protocols > LLC2 > Frame Relay Mapping
Default:	None
Options:	Standard MSB Token Ring MAC addresses
Function:	This parameter provides the local MAC address, mapping incoming requests on this DLCI to that address. The local MAC address must be unique, with only DLCI mapping for a specific MAC address.
Instructions:	If the incoming connections are valid, enter the MAC address of the recipient.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.9.1.4

LLC2 Frame Relay PVC Mappings Parameters

The LLC2 Frame Relay PVC Mappings window (Figure A-4) allows you to edit and delete frame relay mappings that you previously configured.

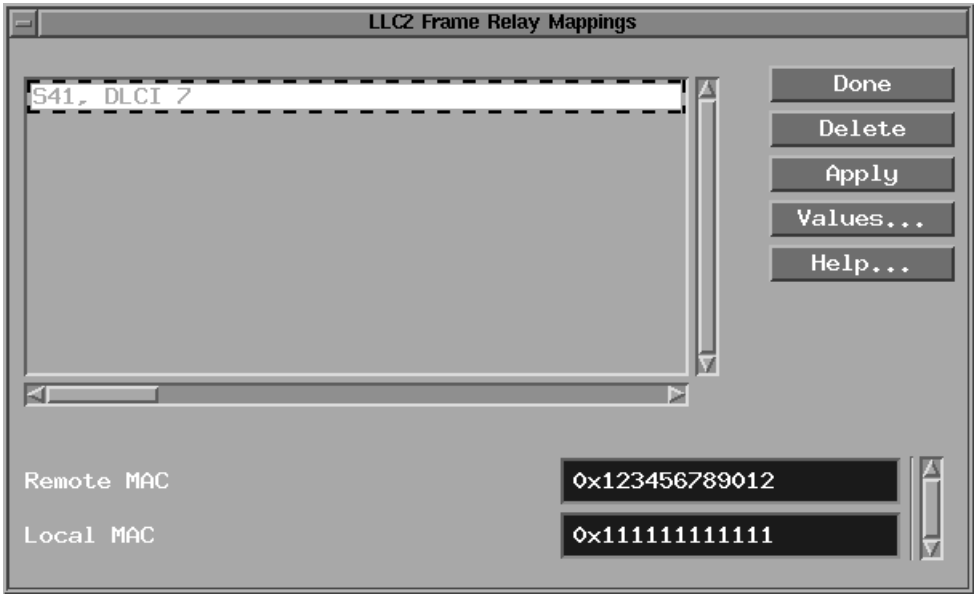

Figure A-4. LLC2 Frame Relay PVC Mappings Window

LLC2 Global Parameters

The Edit LLC2 Global Parameters window (Figure A-5) lets you enable or disable LLC2 on the router.

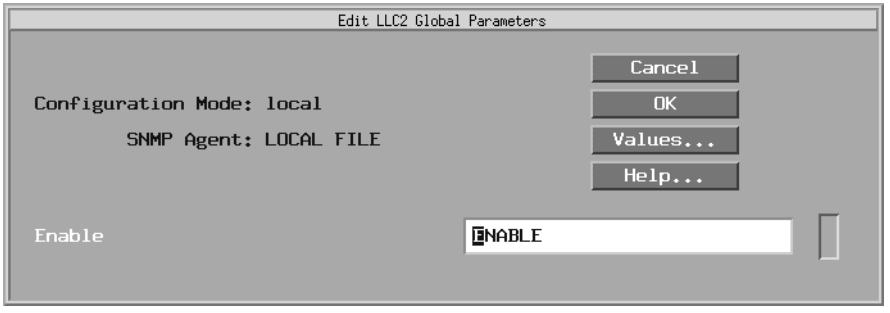

Figure A-5. Edit LLC2 Global Parameters Window

Parameter:	**Enable**
Path:	Protocols > LLC2 > Global
Default:	Enable
Options:	Enable | Disable
Function:	Globally enables or disables the system software mechanisms that, in turn, allow (or do not allow) users to add an LLC2 interface to any 802.*x* LAN physical circuit. You can configure only one LLC2 interface per physical LAN circuit. Other significant actions the system software performs when you choose a setting for the LLC Enable parameter include: Disable -- Forces every LLC2 interface on this node into the inoperative (down) state. Enable -- Reinitializes every LLC2 interface on this node, with each interface maintaining the most recent setting of its own interface Enable parameter. The actual operating state of each interface further depends on the current (up/down) state of the associated physical circuit.
Instructions:	Select Disable to force every LLC2 interface existing on this node into the inoperative (down) state. Select Enable only when an existing LLC2 interface is in the Disabled state.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.1.2

LLC2 Interface Parameters

The LLC2 Interface Configuration window (Figure A-6) lets you customize LLC2 interface parameters for specific clients such as DLSw and LAN Network Manager. These and other LLC2 clients may be configured on the same physical circuits and, therefore, share the same LLC interfaces. In such cases, you can determine a compromise profile of LLC2 parameter settings that satisfy the combined recommendations of the LLC2 clients.

Note: The Edit LLC2 Interface window has the same parameters as the LLC Interface Configuration window. The Edit LLC2 Interface window shows only the circuit you have highlighted from the Circuit Definition window. Refer to *Configuring and Managing Routers with Site Manager* for information on editing circuits.

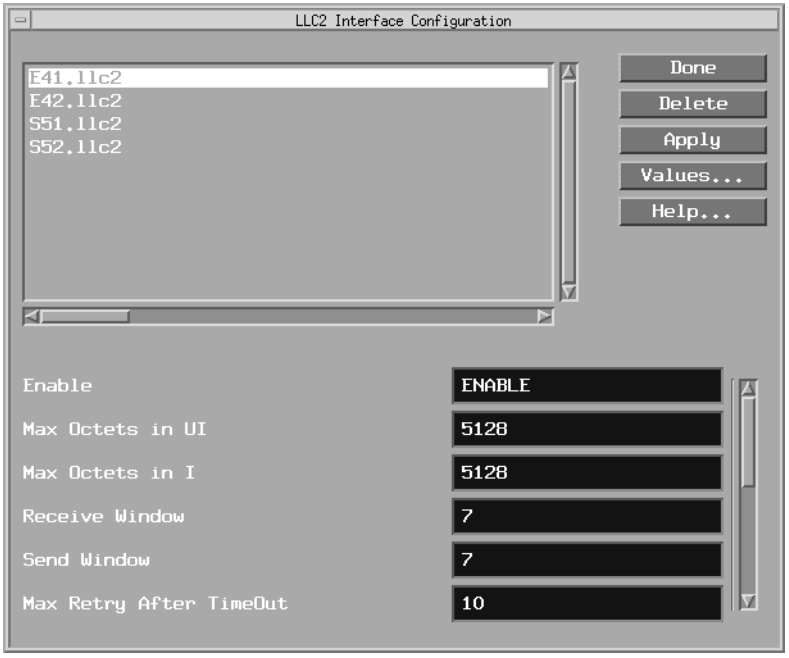

Figure A-6. LLC2 Interface Configuration Window

Parameter: Enable

Path: Protocols > LLC2 > Interfaces

Default: Enable

Options: Enable | Disable

Function: Enables or disables the LLC2 interface added previously to this LAN physical circuit.

Instructions: Select Enable if you disabled this LLC2 interface previously and now want to reenable the interface on its associated LAN physical circuit.

Select Disable if you want to disable this LLC2 interface on its associated LAN physical circuit.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.2

Parameter: Max Octets in UI

Path: Protocols > LLC2 > Interfaces

Default: 5128 (octets)

Options: 1 to 5128

Function: Specifies, in octets, the maximum size of an unnumbered information (UI) PDU that this LLC2 interface sends or receives.

Instructions: Enter a valid value from 1 octet (8 bits) to 5128 octets. Choose a value that is appropriate for the applications LLC2 supports.

The LLC sublayer imposes no restrictions. However, all MAC sublayers must be capable of accommodating UI PDUs with information fields up to 128 octets in length.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.6

Parameter: Max Octets in I

Path: Protocols > LLC2 > Interfaces

Default: 5128 (octets)

Options: 1 to 5128

Function: Specifies, in octets, the size of an information (I) PDU that this LLC2 interface sends or receives.

Instructions: Enter any valid value from 1 octet (8 bits) to 5128 octets. Choose a value that is appropriate for the applications LLC2 supports.

Refer to the various MAC descriptions to determine the precise value you should select for the given medium. All MACs must be capable of accommodating I format PDUs with information fields up to 5128 octets in length.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.9

Parameter: Receive Window

Path: Protocols > LLC2 > Interfaces

Default: 7 (PDUs)

Options: 1 to 127

Function: Specifies a maximum number of unacknowledged information PDUs that LLC can receive. LLC drops frames it receives outside this window and recovers them via timers.

Instructions: Enter any valid value from 1 to 127 LLC PDUs.

For sessions that do not negotiate XIDs (SNA PU 2.0 and NetBIOS), set the router Receive Window to the largest end station's send window. If the Receive Window is too small, the router discards frames it receives outside this window. Timers recover these frames, and dropping these frames degrades performance. On a mainframe's front-end processor, the Max Out parameter in the NCP controls the front-end's transmit window. Therefore, if the Max Out in the NCP is set to 127, you should set the router Receive Window to 127.

For sessions which negotiate XIDs (SNA PU 2.1), the Receive Window sets dynamically during connection establishment. The router uses the value specified here as an upper limit and negotiates downward.

Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.22

Parameter: Send Window

Path: Protocols > LLC2 > Interfaces

Default: 7 (PDUs)

Options: 1 to 127

Function: Specifies a maximum number of information PDUs that can be outstanding (sent or transmitted) at any given time. The value serves as a default Send Window size when no other size has been set by an XID information-exchange procedure.

Instructions: Enter any valid value from 1 to 127 LLC PDUs.

For sessions that do not negotiate XIDs (SNA PU 2.0 and NetBIOS) set the router Send Window to the minimum end station's receive window. If the Send Window is too large, end stations discard frames they receive outside their receive window. Timers recover these frames, and dropping these frames degrades performance.

For sessions that negotiate XIDs (SNA PU 2.1), the Send Window sets dynamically during connection establishment. The router uses the value specified here as an upper limit and negotiates downward.

Choose a value that is appropriate for the requirements of the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.23

Parameter: Max Retry After TimeOut

Path: Protocols > LLC2 > Interfaces

Default: 10 (retransmissions)

Options: 1 to 10

Function: Specifies the maximum number of times that a PDU can be sent following expiration of the ack timer for xmt or the reject timer.

Instructions: Enter a valid value, from 1 to 10 retransmissions. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.7

Parameter: Ack Timer for Xmt

Path: Protocols > LLC2 > Interfaces

Default: 1 (s)

Options: 1 to 15

Function: Specifies the amount of time, in seconds, during which the local LLC expects to receive:

- An acknowledgment for one or more outstanding I PDUs sent during the timer window
- A response PDU for an unnumbered command PDU sent during the timer window
- A response PDU with the F bit set

Instructions: Enter a valid value from 1 to 15.

The default value (1s) works with most environments, but may be too small if the LLC connection is over frame relay, a source route network with multiple hops, or if the end station responds slowly to I Frames.

Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.13

Parameter: Reject Timer

Path: Protocols > LLC2 > Interfaces

Default: 1 (s)

Options: 1 to 30

Function: Specifies the amount of time, in seconds, during which the local LLC expects to receive a reply to a REJ PDU (frame reject response PDU).

If the reject timer expires and no reply has been received for the REJ PDU sent by the local LLC, the local reject timer restarts, and LLC retransmits the REJ PDU. (The total number of times that a specific REJ PDU can be retransmitted depends on the setting of the Max Retry After TimeOut parameter.)

Instructions: Enter any valid value, from 1 to 30.

The default value (1s) works with most environments, but may be too small if the LLC connection is over frame relay, a source route network with multiple hops, or if the end station responds slowly to I Frames.

Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.14

Parameter: Busy Timer

Path: Protocols > LLC2 > Interfaces

Default: 60 (s)

Options: 1 to 60

Function: Specifies the amount of time, in seconds, during which the local LLC waits for an indication from a remote LLC that it is ready to receive PDUs from the local LLC. (The busy condition at the remote LLC has been cleared.)

If the remote busy timer expires and no indication has been received that the remote busy condition has been cleared, the remote busy timer restarts and LLC again waits, either for the remote busy cleared indication or for expiration of the remote busy timer interval.

Instructions: Enter any valid value from 1 to 60. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.15

Parameter: Inactivity Timer

Path: Protocols > LLC2 > Interfaces

Default: 30 (s)

Options: 1 to 30

Function: Specifies the amount of time, in seconds, during which the local LLC expects to receive a PDU soliciting the status of the remote LLC.

If the inactivity timer expires, the local LLC sends an S format PDU with the P bit set to solicit the status of the remote. It initiates the ack timer to handle retries.

Instructions: Enter any valid value from 1 to 30.

This timer detects when an end station no longer responds. The router uses the following formulas to recognize a nonresponsive LLC end station:

Inactivity Timer + (Ack Timer for Xmt * Max Retry After TimeOut)

Defaults: 30 + (1 * 10) = 40 seconds

If you increase the Ack Timer for Xmt parameter value, then you should consider decreasing the Inactivity Timer parameter value.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.18

Parameter: Max Links

Path: Protocols > LLC2 > Interfaces

Default: 255 (logical connections)

Options: 4 to 5000

Function: Specifies the maximum number of logically independent, end-to-end connections the local LLC2 interface can allocate.

Instructions: Enter any valid number of end-to-end connections, from 4 to 5000. Choose an appropriate value for the aggregate performance requirements of all the applications that this LLC2 interface supports. Be aware that higher settings reduce the amount of available memory.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.20

Parameter:	**Frame Relay Virtual MAC Address Mask**
Path:	Protocols > LLC2 > Interfaces
Default:	0x400000FF
Options:	Octal string
Function:	This mask specifies the upper 2 to 4 bytes of a virtual destination MAC address. The lower remaining bytes specify the DLCI to be used.
Instructions:	Select a mask that is unique within your network. The mask should be the upper 2 to 4 bytes of a standard MSB token ring MAC address.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.2.1.26

Parameter:	**Virtual Ring Number**
Path:	Protocols > LLC2 > Interfaces
Default:	None
Options:	0x1 to 0xfff
Function:	Indicates a ring number for LLC to use if you configure APPN with source route bridging. The ring number must be unique in the SRB network.
Instructions:	Select a hexadecimal number from 0x1 to 0xfff that is unique in your SRB network.
MIB Object ID:	1.3.6.1.4.1.18.3.5.1.6.2.1.25

Appendix B
Monitoring LLC Using the BCC show Commands

This appendix describes how to use the BCC **show** commands to obtain LLC data from the management information base (MIB). The type and amount of data displayed depends on the specific LLC information you want to view. This appendix includes descriptions of the following **show** commands:

Command	Page
show llc2 all	B-2
show llc2 interfaces	B-3
show llc2 links	B-4
show llc2 summary	B-5

show llc2 all

The **show llc2 all** command shows all the information you can display using the **show llc2 interfaces**, **show llc2 links**, and **show llc2 summary** commands.

This command does not use command filters (flags).

The output includes the following information:

LLC2 Interfaces	
Circuit Name	Circuit name assigned to the interface.
State	State of the LLC service: up, down, init (initializing), disabled, or absent.
Max Links	Maximum number of end-to-end connections per LLC service.
Receive Window	Maximum number of unacknowledged information PDUs that LLC can receive.
Transmit Window	Maximum number of information PDUs that can be outstanding at any given time.
Encapsulation	The encapsulation technique that should be used by LLC: default, token-ring, csmacd, source-routing.
LLC2 Connections Table	
Circuit Name	Circuit name assigned to the interface.
Dest MAC	The MAC address of the remote station.
Src MAC	The MAC address of the local station.
Dsap	One or more SAPs for which the LLC PDU is intended.
Ssap	The specific SAP that initiated the PDU.

show llc2 interfaces

The **show llc2 interfaces** command displays general information about LLC2 interfaces, including the current operational status and interface type.

This command allows for the following command filter (flag) and argument:

-interfaces <*circuit-name*>	Displays information for the specified interface only.

The output includes the following information:

Circuit Name	Circuit name assigned to the interface.
State	State of the LLC service: up, down, init (initializing), disabled, or absent.
Max Links	Maximum number of end-to-end connections per LLC service.
Receive Window	Maximum number of unacknowledged information PDUs that LLC can receive.
Transmit Window	Maximum number of information PDUs that can be outstanding at any given time.
Encapsulation	Encapsulation technique that LLC should use: default, token-ring, csmacd, source-routing.

show llc2 links

The **show llc2 links** command displays general information about connections on the router.

This command allows for the following command filter (flag) and argument:

-interface <*circuit-name*>	Displays information about connections on the router for the specified interface only.

The output includes the following information:

Circuit Name	Circuit name assigned to the interface.
Dest MAC	The MAC address of the remote station.
Src MAC	The MAC address of the local station.
Dsap	One or more SAPs for which the LLC PDU is intended.
Ssap	The specific SAP that initiated the PDU.

show llc2 summary

The **show llc2 summary** command displays general information about LLC2 interfaces, including current operational status, interface type, and number of max links configured. This command also shows whether global LLC2 is enabled.

This command does not use command filters (flags).

The output includes the following information:

Circuit Name	Circuit name assigned to the interface.
State	State of the LLC service: up, down, init (initializing), disabled, or absent.
Max Links	Maximum number of end-to-end connections per LLC service.

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